Abstract

A fractal model of the cosmos is presented by demonstrating a self-similarity between the Universe and the infamous Mandelbrot Set iterated function system (M-Set1). Current cosmological models involve numerous mathematical formalisms supported by a complex language of cryptic symbols often wrapped in confusing or counter-intuitive theories. But what if there existed a model or system that required only “one” equation (or mathematical formula) with “zero” parameters and could reproduce “all” the observables of the Universe? And, what if we could solve this equation using only addition and multiplication, and no calculus? According to Occum's Razor, this description of the Universe would be preferable, as long as it does not contradict observation or experimental fact. Using the computer as my telescope, microscope and particle accelerator, I studied in great detail one of the simplest iterated function systems (IFS), M-Set, and uncovered an unmistakable self-similarity between M-Set and our Universe. In this framework, an analogy for gravity is presented leading to a new interpretation of singularities, black holes and event horizons. The complex morphologies of galaxies and galaxy clusters are easily reproduced using the simple techniques outlined in this essay. Particle dynamics and magnetic fields are also strangely encoded into this strange attractor. The concepts of matter, antimatter and light are explained in the context of this new paradigm leading to a new interpretation of Planck's constant and it's associated units of length, mass and time. In short, the M-Set-Universe analogy presented in this essay points a self-similar fractal universe where all the forces in nature can be seen as emergent properties a very simple mathematical formalism in close alignment with the Mandelbrot Set iterated function system.
Introduction

The primary motivation of this essay is to present an alternative explanation for the origin and evolution of our Universe. Current cosmological theories involve various mathematical formalisms that are (for all intents and purposes) “calibrated” to fit experimental fact. From relativity to quantum mechanics, there are literally dozens if not hundreds of equations, parameters and constants used to describe all material interactions. In computer science, this is often referred to as “curve fitting”. But what if all the observables in the Universe could be explained using a much simpler set of rules requiring only one equation and no parameters? And what if, only addition, multiplication and no calculus were required to solve this equation or system? According to Occam's Razor, this would be preferable to the more complex models derived from modern cosmology. Of course, such a formula would have to reproduce “all” the observables and must not contradict experimental fact to be taken seriously. This is a difficult task for any theory including the standard model which is continuously modified (calibrated) to account for new information. For example, the flat rotation curves of galaxies was totally unexpected and therefore was not predicted by standard theories at the time. To solve this problem the idea of dark matter was introduced to account for the alleged missing mass. Dark energy was also “devised” to account for the unexpected observation of the accelerating expansion of the Universe. However, if the big bang theory was the correct interpretation for origin of the cosmos, then why didn't it predict the flat rotation curves of galaxies or the accelerated expansion of the Universe? Instead of continuously “tweaking” the current model to fit observation (as was done in the days of the epicycles), I suggest that an alternative approach or model could be used to solve these problems.

The concept of fractals is relatively new, developed and popularized by Benoit Mandelbrot (1935-2010) in the 1970's and 1980's. Mandelbrot actually coined the term "fractal" to describe rough geometric shapes that have fractional dimensions. When modern physics was being developed and formalized (late 1800's early 1900's) there was no concept of fractal and therefore no language with which to include them in their theoretical formalisms. Even Stephen Hawking admits that he does not know how to fit fractals into the standard model of cosmology. In the introduction to his paper “Virtual Black Holes”, he states the following: “One might expect this space-time foam to have very complicated structure, with an involved topology. Indeed, whether space-time has a manifold structure on these scales is open to question. It might be a fractal. But manifolds are what we know how to deal with, whereas we have no idea how to formulate physical laws on a fractal.” (ref)

What he is saying is that a fractal “manifold” is very difficult to deal with using standard
techniques because there are no clear boundaries with which to make measurements. In other words, calculus does not work well on fractal manifolds and therefore, differentiable manifolds are preferable. Exploring fractal Universes requires a paradigm shift involving new laws and new tools. Hawking admits that he does not know how to formulate physical laws on a fractal, however, he what he didn't consider was the possibility that these “laws” might emerge naturally from a fractal geometry.

It is hard to imagine how a simple model with only one “equation” could bring about the vast complexity of our Universe. That said, the fractal, and in particular the Mandelbrot Set, is a great example of how complexity can arise from a relatively simple set of rules. In this essay, I argue that the Universe exists and evolves as a nonlinear chaotic dynamical system or iterated function system that generates fractal patterns (organized matter) at all knowable scales. In such a system, the “laws of physics” become emergent properties (of the system) which can then be detected and measured using standard techniques. By analyzing the dynamics of M-Set (\(z=z^2+c\) where z and c are complex numbers) I show how gravity, black holes and event horizons can emerge. I am able to reproduce the very specific morphologies of galaxies and galaxy clusters. Magnetism and particle dynamics are also strangely encoded and easily reproduced. Time and energy can also be seen as emergent properties of such a system. In the end, I propose that a complete Cosmology could be developed by modelling the Universe as an iterated function system that is closely aligned with the Mandelbrot Set as described in this essay.

Being a computer scientist has put me in a unique position to pursue this line of thinking since most complex chaotic dynamical systems can only be explored (in great detail) using a computer. I am able to write my own programs and run my own simulations. The study of computers has also given me some surprising insights into the computer-like nature of our Universe which will also be discussed throughout this essay. There is an old saying, “The proof is in the pudding” meaning that the true value or quality of something can only be judged when you experience it yourself.

Fractal pudding anyone?
Fractals Overview

According to Benoît Mandelbrot, a fractal is “a rough or fragmented geometric shape that can be subdivided in parts, each of which is (at least approximately) a reduced/size copy of the whole.” Although this captures the essence what a fractal is, one definition doesn't seem to do it justice. Here are a few definitions I came up with that encapsulate all the aspects (and features) of fractals that I believe are important in my M-Set-Universe analogy:

1) Fractals represent the emergent properties of chaotic dynamical systems or iterated function systems. The dynamics generated by these systems exhibit both predictable (bounded) and unpredictable (uncertain) behaviour.

2) Fractal patterns manifest as coherent structures of complex morphologies.

3) All fractal patterns have the property of self-similarity (scale invariance) and have fractal dimensions associated with them.

4) Fractals are patterns or “pictures” that capture the essence of the dynamics going on in a complex dynamical system.

Fractals are easily generated using a simple set of rules that primarily involve three transformations: translation, rotation and scaling. A simple iterated function system (IFS) generates fractal patterns by recursively applying a set of these transformations to a primordial object. One of the very first fractals ever generated by this method led to an image that looks surprisingly like a fern (Figure 1). It is interesting to note that that the fern is one of the oldest and most common plant species on this planet so it is not surprising that it can be so easily reproduce using simple mathematical rules.
Figure 1: A fractal fern generated using iterate function system (IFS).

The most important of these transformations is scaling without which there would be no fractals. You can make fractals without rotations (Figure 2) but the most interesting fractals incorporate all three transformations (rotation, translation and scaling). As we will see in the next section, all three transformations are encoded into the M-Set system which may explain why it is such a great fractal pattern generator.
The idea of fractal dimension, where a dimension can be assigned a fractional (non-integer) number as opposed to a whole (integer) number, is key to understanding fractals. According to Mandelbrot, an object is fractal if its fractal dimension exceeds its topological dimension (1). For example, a “curve” with a fractal dimension of 1 would behave very much like an ordinary line but a curve with a fractal dimension of 1.8 (for instance) would twist and turn through space thus behaving more like a 2-dimensional surface. These are often referred to as space-filling curves. Fractal dimension is generally used as a measure of complexity of a fractal pattern, thus, a curve with fractal dimension of 1.2 would be less complex than a curve with fractal dimension of 1.9.

Self-similarity is another feature of fractals which is important to the understanding of the theory presented in this essay. In mathematics, a self-similar object or pattern has the same (or similar) shape as one or more of its parts. This is also referred to as scale invariance. The Sierpinski Gasket in Figure 2 is an example of a fractal with self-similarity that is exactly replicated at each scale. I refer to these fractals as self-same. There are other fractals such as the Mandelbrot Set that generates fractals that are NOT exactly the same at different scales and are therefore self-similar. M-Set is an example of a self-similar curve.
In this essay, I argue that the Universe is a self-similar (not exactly repeating) non-linear dynamical system with similar “dynamics” appearing different scales. This leads to a Universe that is fractal at all observable scales with no cross over to homogeneity.
Mandelbrot Set Overview

It has always been my contention that there was something special about the Mandelbrot Set. I have been exploring this “mathematical monster” since the mid 1980's when all I had was a Commodore-64 hooked up to a television. In those days, it took could take several weeks to generate just one M-Set image. Today, we can fly through the Mandelbrot Set in real time using the latest CPU and GPU technologies. The algorithm used to generate M-Set is extremely CPU intensive as each point on the screen may require thousands if not tens of thousands of calculations (iterations) to resolve.

Figure 3: This image is a map of the complex plane as iterated through the function $z = z^2 + c$. (Appendix A). The black region in the middle correspond a black hole in my model. The gradient regions surrounding the black hole correspond white holes. The complex (curved)
region between the black hole and the white hole corresponds to an event horizon. The digits in this image (1-7) represent the number of iterations needed for these points to reach escape velocity. Notice that the outer regions require less iterations to escape than the inner regions.

Benoit Mandelbrot (1935 – 2010) is considered the founder of fractal geometry and the discoverer of the most famous fractal of all the Mandelbrot Set. He coined the term “fractal” to describe the complex geometric shapes that have the property of self-similarity. Using the best computer technology at the time (late 1960's), and only a few lines of computer code, Mandelbrot was able to resolve this rich set of never before seen (never ending) complex (fractal) patterns. Mandelbrot was able to apply his new found fractal geometry to the field of cosmology by proposing a new explanation of Olbers' paradox based on fractal distribution of stars and galaxies. In this work, he argued that a fractal distribution (of matter) would solve this paradox without the need for a finite expanding universe or a big bang.

Recent observations indicate a fractal distribution of stars and galaxies over many orders of magnitude, although a cross-over to homogeneity is often assumed. A fractal universe without crossover was proposed by Mandelbrot in 1989. This allegedly created another problem resulting in a vanishing density for very large volumes. I propose that this “problem” could be resolved by modelling the Universe as a computer with a limited number of bits or digits of precision. This would prevent the “large-volume/vanishing-density” problem and could also serve to explain the, the non-infinite collapse of singularities as well as a finite speed of light. It turns out, our Universe actually does have a limit to its “digits of precision” commonly referred to this the Planck limit. This points to the computer-like nature of the Universe as discussed throughout this essay. Let us first take a few steps back and have a closer look at “The Mandelbrot Set” in order to understand how it fits into the field of Cosmology.
Complex Numbers and M-Set

M-Set finds its home in the 2-dimensional complex plane. It is a map of how real numbers interact with imaginary numbers when iterated through the function:

\[ z = z^2 + c \] (1)

where \( z \) and \( c \) are complex numbers. Complex numbers were devised in order to solve problems that cannot normally be solved using real numbers alone (eg. \( x^2+1=0 \)). They are used in math to simplify calculations, in computer graphics to speed up rotations (quaternions are used for 3D rotations) and are an absolute necessity in the current applications of quantum mechanics.

The function associated with M-Set is essentially the simplest 2 dimensional polynomial (function with more than one term) that can be written down. It has only two terms and no adjustable parameters. It is an iterated function system which means that the output from the function gets fed back into the function in a recursive feedback loop. As demonstrated below (2), the polynomial can become quite complex, exhibiting many degrees of freedom after only a few iterations:

\[ z = (((((z^2+c)^2+c)^2+c)^2+c)^2+c)^2+c)... \] (2)

This may explain how such a simple expression (1) could be responsible for the near infinite complexity associated with M-Set.

As mentioned in the previous section, all the transformations of fractals (translation, rotation and scaling) are embedded into the M-Set system. Looking at (1) it is easy to see where the “translation” comes from (+ \( c \)). The “scaling” is also obvious in that by squaring a number, you are either making it larger (for numbers greater than one) or smaller (for numbers less than one). Squaring also implies acceleration which is required for any forces to be present. The “rotation” transformation is not so obvious but is derived from the fact that when you multiply two complex numbers, you are in fact generating a rotation in a 2D plane. Thus, squaring a complex number generates the rotation component of the transformation.

All transformations of M-Set are applied via the iteration process. The concept of iteration is the key to understanding the M-Set cosmology presented in this essay. To help lay the ground work for further discussions, I outlined the general algorithm used to generate M-Set in
Appendix A. It is advised that you read this appendix before proceeding. In short, when you iterate points from the complex plane through the function (1) some of the points reach escape velocity\(^8\) and some points do not. The points that do not escape are are said to be “inside the Mandelbrot Set” and are traditionally painted black as shown in Figure 4a. The points that do reach escape velocity are said to be “outside the Mandelbrot Set” and are painted a certain colour depending on how many iterations it takes to escape (Figure 4b). I refer to these points as the Buddhabrot Set\(^9\).

If you study this algorithm (Appendix A), you will notice that the escaping points can be resolved with absolute certainty, but that all other points are uncertain. That said, I was able to develop a method (Appendix B), which takes advantage of the limit to the digits of precision of the computer, and is able to detect for certain some of the non-escaping points from M-Set. This leaves a thin boundary of points which are not resolved (Figure 4c). I refer to this as the boundary of uncertainty. (Benoit Mandelbrot called this boundary S for separator in Fractal Geometry of Nature\(^10\)). This boundary separates the points in the complex plane into two distinct bins. One bin contains all the points that can and do reach escape velocity (Figure 4b, the grey and black points) and the other bin contains all the points that never escape (Figure 4a, the black points). In the M-Set cosmology analogy in this essay, the non-escaping points or regions in M-Set are analogous to black holes, the greyscale outer regions are analogous to white holes and the boundary of uncertainty is analogous to an event horizon.
**M-Set Cosmology**

In this essay, I propose a cosmology based on a self-similarity (or analogy) between the Mandelbrot Set mathematical construct (M-Set) and the Universe. Put simply, the Universe is an M-Set and M-Set is a Universe. M-Set is a Universe in its own right. It is both boundless and bounded and has an infinite capacity to generate unique forms at all (observable) scales. Figure-5 suggests an intrinsic relationship between M-Set and the Universe we observe. Although, M-Set is an algorithm run on a computer, I argue that the Universe is also “a kind of” computer and show evidence of this throughout this essay. The proposed Mset-Universe analogy is defined in as following:

1) Iteration in M-Set is analogous to energy in the Universe, where one iteration is associated with 1 unit of energy.

   \[ \text{Iteration} \sim \text{Energy} \]

2) Given the energy-mass equivalence (\(E=MC^2\)), iteration is also associated with mass.

   \[ \text{Iteration} \sim \text{Mass} \]

3) Points on the complex plane are associated with particles in a complex space.

   \[ \text{Points} \sim \text{Particles} \]

4) Escape velocity is analogous to the velocity of light.

   \[ \text{Escape Velocity} \sim \text{Velocity of Light} \]

5) Iterating a point (through the function \(z=z^2+c\)) is analogous to accelerating a particle.

   \[ \text{Iteration} \rightarrow \text{Acceleration} \]
Figure 5: This image represents a set of ransom singularities generated by M-Set. See section (xx) for details.
Mass and Gravity

Gravity is described as the force of attraction between two bodies that have mass. Although mass is thought to be the “cause” of gravity, the cause of “mass” itself is still unknown and hence the root cause of gravity is still somewhat of a mystery. The concept of gradient is the key to understanding gravity (and all the forces) in the context of the M-Set cosmology presented in this essay. A gravitational field can be thought of as a gradient of gravitational potential. Electrical and magnetic fields can also be thought of as gradients of potential fields. Without gradients there would be no forces and without forces, there would be no dynamics, thus the Universe (and M-Set) would be blank.

Mass and gravity emerge in M-Set via the iteration process. Figure-4 demonstrates the three distinct fates of points from the complex plane as iterated through the function (1). Some points are able to reach escape velocity given a finite number of iterations (Figure 4b, greyscale gradient regions), some points never escape (Figure 4a, black region) and some are uncertain (Figure 4c, black points). An analogy for gravity can be found in M-Set by looking more closely at the fate of the points from the complex plane as iterated through the function (1).

Given the iteration-energy equivalence, the gradient regions in Figure-6 can be interpreted as density gradients where the lighter regions (less iterations) represent regions of less density and the darker regions represent regions of greater density. These energy or density gradients are analogous to gravity in my model. Figure-6 also demonstrates an increase in curvature as we get closer to the black hole region (at the centre of the image) also indicative of a gravitational effect.
Figure 6: This image is a scaled region of M-Set showing an increase in iteration from the light to dark regions. It also demonstrates an increase in curvature as we look closer to the black central region.

In M-Set, all these gradient patterns (organized matter) seem to be associated with and/or connected to these black regions which I argue are black holes. From this I propose that all (gravitational) forces and associated organized matter in our Universe are also connected to black holes.
Black Holes, White Holes and Event Horizons

Black Holes

Black holes are cosmic objects with massive gravitational fields that curve space-time so drastically that nothing, including light can escape the boundary or event horizon of the black hole. In the M-Set model, the non-escaping points or regions from the complex plane are analogous to black holes. By letting iterations be analogous to energy (iteration ~ energy), then the points on the inside of the M-Set will never reach escape velocity even given an infinite amount of energy. In other words, these points are behaving exactly as if they are inside a black hole. As you can see from Figure-6 below, the curvature of the gradient regions increases as you look closer to the black hole region, reminiscent of black hole space-time curvature.

White Holes

White holes (in general relativity) are hypothetical regions of space-time from which matter (and light) may escape. They are for all intents and purposes, the reverse of black holes. According to GR, a white hole event horizon in the past becomes a black hole event horizon in the future. However, also according to GR, there is no physical process through which a white hole can be formed and therefore, they are only hypothetical constructs of this model and cannot and do not exist in reality.

In my M-Set model, white holes do exist and are represented by the points in the complex plane that can and do reach escape velocity. Their behaviour is exactly the opposite of the black hole points as will be demonstrated more explicitly in the next section on singularities. In this construct, the black-whole and white-hole regions coexist and are mutually exclusive.
Figure 6: Depicting the Black Hole, White Hole and Event Horizon components of M-Set

Event Horizons

An event horizon is the boundary that separates the outside of a black hole from the inside. Once inside, nothing can escape the event horizon of a black hole, not even light. It is often referred to as the boundary of no return. The boundary of the Mandelbrot Set (Figure 4c) is an event horizon in the truest sense. It is the boundary that separates the escaping points from the non-escaping points (the white hole from the black hole). Here I reiterate that the points from the outside of the M-Set can and do reach escape velocity given a finite number of iterations or energy. The points from the inside will never escape the event horizon even given an infinite number of iterations or energy. In this essay, I argue that this boundary, generated by M-Set, is analogous to or self-similar to the event horizon of a black hole. I also argue that the black holes and event horizons of modern cosmology are only crude approximations to the actual black holes.
and event horizons that the Universe creates which appear to me more in alignment with my M-Set cosmology.

![Fractal Morphologies](image.png)

**Figure 7:** Image on the left is a region of M-Set which is self-similar to the galaxy on the right. (NGC 1232, Image Credit: European Southern Observatory). Notice the similarities between the shapes of the spiral arms as well as the interaction between bright regions and voids, suggesting a chaotic process may be associated with galaxy formation.

The above figure (Figure-7) demonstrates how the fractal morphologies of galaxies are easily reproduced using the M-Set model. These complex morphologies are much more difficult to explain in the standard model. In my M-Set cosmology, I argue that the whole of the galaxy is an event horizon which is coexisting with (in symbiotic relationship with) its central black hole. Recent advances in black hole research indicate black holes and galaxies may in fact coexist in this manner\(^{11}\).

**Chaotic orbits around Black Hole**

More evidence of the black hole nature of M-Set can be found in the following experiment. An initial complex point was selected from the set of escaping points and iterated. Each point generated by the iteration process was plotted. Then a point closer to the black hole region was selected and iterated and so one. The process continued until a point was selected that was detected to be inside of the black hole according to the algorithm in Appendix B. This is equivalent to “falling” a particle into a black hole according to my analogy. The image on the right in Figure-8 represents the results of this experiment. Notice the similarity between this
image and the one on the left which represents 16 years of the most detailed observations of stars orbiting the centre of our galaxy. It is assumed that the centre of our galaxy is a black hole.

Figure 8: The image on the left represents 16 years of data consisting of the most detailed observations yet of the stars orbiting the centre of our galaxy, bolstering the case that a monstrous black hole lurks there. The image on the right represents the orbits of particles “falling into” the “event horizon” of the M-Set black hole. Notice the similarity between these two dynamical systems.
Singularities

In astrophysics, a singularity is a point of infinite density and infinitesimal volume, and according to General Relativity, where space and time become infinitely distorted. According to the big bang theory, a gravitational singularity existed at the beginning of the universe. Singularities are also thought to exist at the centre of black holes.

Singularities in M-set are generated using the non-escaping points from the black hole region(s). When a complex point is iterated through the function (1) it carves out a trajectory or orbit as demonstrated in Figure-9.

Figure 9: This figure shows three singularities from the inner or non-escaping points of M-Set. The large circle (in each of A,B,C) represents the starting point or initial conditions. The rest of the points map out the trajectory generated by the iteration process. In the top images, I link each point with a line to show the order with which these points were generated. The bottom
images represent the same singularity only without linking the points. I refer to these as black hole singularities.

A) Real: 0.25671428571428567, Imaginary: -0.02857142857142847, CycleCount: 1
B) Real: -0.53757142857142881, Imaginary: -0.17142857142857149, CycleCount: 2
C) Real: -0.27471428571428591, Imaginary: -0.61142857142857143, CycleCount: 11

Theoretically, like cosmological singularities, M-Set singularities are capable of infinite or continuous collapse. If we had time for an infinite number of iterations and if the computer had an infinite number of digits of precision, these singularities would forever collapse toward an infinitely small region in the complex plane. As well, these singularities would be considered to have infinite mass according to the iteration-energy equivalence of the M-Set cosmology. And, similar to cosmological singularities, these singularities break down at the quantum scale, Figure-xx. Why does it break down?

Figure xx: Following a singularity down to the quantum level. The first two images (a,b) show the singularity at two different scales. Image c) shows the breakdown at the quantum level. The star in the middle represents a loop-5 singularity. (See: Appendix B)

**Singularities and Planck Scale**

On further investigation, I discovered that the break down of the M-set singularity is caused by the limit to the digits of precision (bits) of the computer. As the singularity collapses, the spacing between adjacent points get smaller and smaller. Eventually, the spacing is so small
that it can no longer be measured by the computer. It is at this point that the collapsing trajectory breaks down and fails to collapse any further.

According to the IEEE standard,\(^\text{12}\) a 32-bit computer can only represent \(~17\) digits of precision and a 64-bit computer can only represent \(~34\) digits of precision (at any one scale). In this manner, the quantum limit (the limit with which we can make measurements) of a 32-bit computer can be said to be \(~10^{\wedge}-17\) and the quantum limit of a 64-bit computer can be said to be \(~10^{\wedge}-34\).\(^\text{13}\) This is strangely close to the Planck limit (\(~10^{\wedge}-34\)) and, for all intents and purposes, has the same meaning as Planck limit. Admitting that there is a Planck limit (in our Universe) is to admit that there is a limit to the digits of precision of the Universe. Admitting that the Universe has a limit to the digits of precision is to suggest that the Universe is a kind of computer, with a limit to the “digits of precision” similar to a modern day 64-bit computer.

**Complex Irrational Singularities**

In order to get past the “digits of precision” limitation to the computer, I developed my own fixed point math library which I used to extend the digits of precision of the computer. Using this new tool, I followed these singularities down to thousands of decimal places. What I discovered was that these trajectories continue unabated, down to the new quantum level, depending on the number of digits of precision chosen. In analyzing the digits generated by these collapsing singularities, I discovered that the sequence of digits (to the right of the decimal place) appear to be random and non-repeating, indicative of irrational numbers. See Appendix D (TBD) for details on this algorithm. At first glance, they look like irrational numbers and it makes sense that, in order for these singularities to collapse indefinitely (in a non-repeating manner) they must be “falling toward” and/or attracted to complex irrational numbers.

**Loop Singularities**

The other thing I discovered was that when the collapse of these singularities is stopped (by the limit to the digits of precision of the computer), it actually falls into a repeating pattern of one or more cycles. I refer to this condition as “loop-singularity” since the singularity ends up falling into a repeating pattern or loop. For instance, Figure 3a falls into a loop one singularity where it (eventually) collapses into a pattern that repeats the same value (the same complex number) over and over. Loop-2 singularities repeat two values over and over again and
so on. Using this to my advantage, I was able to develop an algorithm that can be used to determine for certain whether a point a non-escaping point (Appendix B). In this algorithm, all I have to look for is a repeating pattern in the sequence of complex numbers generated by the iteration process. If a duplicate complex number is found in the set of points, then I can know for sure that it will eventually fall into “loop singularity” and therefore, it is a member of the “black hole” region of M-set. I also discovered that the number of elements in the “loop singularity” is directly proportional to the number of spiral arms in the singularity pattern. For example, Figure-9A is a loop-1 singularity, B is a loop-2 singularity and C is a loop-11 singularity.

**Singularities in Nature**

Benoit Mandelbrot discusses the idea of singularity in his book “The Fractal Geometry of Nature”. He argued that if a singularity is not a geometric shape such as a point, a line or a surface, then it must be a fractal. The singularities presented in this section are self-similar or fractal patterns which appear to be closely aligned with the patterns of nature.

![Figure 10: The image on the left is an M-Set singularity that closely resembles the growth pattern of the plant on the right.](image)

**Anti-Singularities**

As discussed in the previous section, each point from the complex plane generates a unique “dynamic” when iterated through the function (1). Each point from the black hole region generates a contracting dynamic, and conversely, each point from the outside region generates
an expanding or radiating dynamic. As with the singularities in the previous section, each escaping point demonstrates a unique escape rate and pattern (Figure 11). Although these trajectories look very similar to the contracting trajectories from the previous section, these ones are expanding from the inside out (rather than contracting from the outside in). In other words, their behaviour is the complete opposite to the behaviour of the contracting singularities.

Figure 11: This figure shows two anti-singularities from the outside or escaping points of M-Set. Notice the similarity between these and the non-escaping singularities. These singularities start from the centre and spiral out toward infinity. The arrows show the exit points of each dynamic. I refer to these as white hole singularities.

A) Real: 0.25500484715977634, Imaginary: 0.30128918238597435

B) Real: 0.35535240611393998, Imaginary: 0.30597327018769765

Since these expanding singularities are generated by the points that can and do reach escape velocity (speed of light) in M-Set (given a finite number of iterations) I associate these points with particles of light or photons. These are the points that eventually escape and radiate away from the event horizon of the black hole. In a similar manner, I associate the collapsing,
black hole singularities with particles of matter. More on this in a later section.
AntiMatter

Antimatter is the same as matter, only reversed, like looking in a mirror. On the atomic level, antimatter has the same mass but is opposite in charge and has opposite spin. When the two collide, they “destroy” each other and “create” energy. In my M-Set analogy, iteration is analogous to energy and therefore mass where more iterations equates to more mass. Figure xx demonstrates how matter and antimatter manifest in M-Set. Each “test particle” from the complex plane has an equal and opposite “particle” on the other side of the axis of symmetry or the real axis*. Each particle-antiparticle pair takes the same number of iterations to reach escape velocity (for escaping points) or loop singularity (for non-escaping points) and therefore can be considered to have the same mass according to my analogy. The particles to the left of the real axis or axis of symmetry have a negative imaginary component and a clockwise spin. The particles to the right of the axis of symmetry have a positive imaginary component and a counterclockwise spin. If we added these two “particles” together, we would find the imaginary components cancelling, and the real component doubling.
Figure xx: Anti-Matter. The above image shows two singularities from opposite sides of the real axis or axis of symmetry\(^{14}\). Notice that the singularity on the left is spiralling in a clockwise manner while the one on the right is spiralling counter-clockwise. These two singularities are considered as matter-antimatter counterparts in this essay.

In mathematics, complex conjugates are pairs of complex numbers both having the same real part but with the imaginary parts of equal magnitude but opposite signs. Quantum...
mechanics uses complex conjugates extensively to ensure that the probabilities of complex wave-functions result in real values. In the above M-Set analogy, matter and antimatter can be seen as complex conjugates of each other. They have the same real components and equal but opposite imaginary components. If added together (if they collide), the imaginary components collapse to zero and we are left with two times the real component (i.e. two times the energy of the real component). When matter and antimatter “collide”, they are said to annihilate each other with the release the combined energy of each particle.

From the above analogy, I argue that the charge of a particle is a directly related to the imaginary component of the complex function (that generates our Universe), where a negatively charged particle has a negative imaginary component and a positively charged particle has a positive imaginary component. Annihilation is nothing more than complex conjugation of the particle-antiparticle pair. The release energy (in real particle-antiparticle interactions) equates to the collapse of the imaginary component onto the real component which we perceive as the release of energy in the form of light. This indicates that the real component of the complex plane is related to light energy in some manner yet to be determined. In short, we were able to deduce, using the M-Set analogy, that the imaginary component (of M-Set) is related to charge and the real component is related to light. Although this is highly speculative, it is interesting to note for future investigation.[


http://www.bibliotecapleyades.net/ciencia/secret_projects/project297.htm]
The Atom

Figure 12: M-Set model at the scale of the atom. The centre black hole region is analogous to the nucleus of the atom. The quantized regions on the outside of M-Set represent the electrons shell of the atom. The weak force is associated with the event horizon. This is, for all intents and purposes, an atom.

The above image (Figure 12) shows the different regions of the atom according to the M-Set model. It is well known that the electrons can escape the atom given a finite amount of energy. It is also well known that the electrons closest to the nucleus take more energy to escape
the atom (or jump up to another level), than the electrons far away from the nucleus. This is exactly analogous the M-Set model where the points farther away from the black hole (nucleus) take less iterations or energy to reach escape velocity than the points closer to the black hole. Also, notice the quantization of these “electron shell” regions. It is well known that the energy levels associated with electrons are quantized in the atom. This is the source of all electromagnetism.

The strong force associated with the nucleus of the atom is represented by the black hole region of M-Set. The weak force takes a bit more explaining but, is associated with the event-horizon in my model. The event horizon of M-Set is made up of the points of uncertainty or the points that can’t decide if they are on the outside (expanding) or the inside (contracting).

The weak interaction or weak force is responsible for the radioactive decay of subatomic particles and initiates the process known as hydrogen fusion in stars. In other words, the weak force causes things to come together, and it causes things to fall apart. The weak interaction is the only interaction capable of changing one type of quark into another. Most interestingly, it is said to be propagated by carrier particles that have significant masses. In my M-Set model, particles are much more massive near the event horizon of a black hole, more evidence that the weak force is associated with event horizons.

It seems that the Universe re-creates the same pattern over and over at different scales:

The Atom:

- The nucleus of the atom (strong force) is a black-hole.
- The electron shell region is a white-hole (source of all electromagnetism).
- Weak force is the region of uncertainty or event-horizon.

The Galaxy:

- The centre of the galaxy is a black-hole.
- The galactic halo is a white-whole.
- The galactic disk is an event-horizon.
The Solar System:

The centre of our solar system (sun) is a black hole.

The rest of the solar system is the white-whole.

Earth is the event-horizon.

The Cell

The nucleus of the cell is the black-hole (or strange attractor, DNA)

The cell membrane and wall represent the white-hole.

All other parts inside cell represent the event-horizon.

From these arguments and Figure-12, I argue that black-holes are at the centre of all organized matter and can be thought of as strange attractors. All white-holes are quantized (more on this later). Last but not lease, event-horizons are where all the complex behaviours occur. In other words, we ARE the event-horizon of a black-hole.
Galaxy and Galaxy Clusters

Figure-17: M-Set model at the scale of the galaxy. The centre black hole region is analogous to the black hole at the centre of the galaxy. The quantized regions represent the redshift quantization regions where the inner regions are more redshifted than the outer regions. The event horizon is associated with Gamma Ray Bursts (GRB's). The graphic on the right shows the evolution of the quasar according to the work of Halton Arp.

Redshifts

In the section on the atom (section-xx) I argue that the electron shell region is a white-hole and that all white-holes are quantized. I also propose a self similarity between the atom and the galaxy, in which case the galaxy should also exhibit quantized electron shell like regions or behavior. To answer this, I turn to the work of Halton Arp, (from the Max Planck Institute for Astrophysics in Garching, Germany) and William Tift, (Professor Emeritus at the University of
Arp was one of the first to suggest a direct association between high redshift quasars and low redshift galaxies. In his paper, “Evolution of Quasars into Galaxies and its Implications for the Birth and Evolution of Matter” he argues that active galaxies eject quasars along the minor axis (rotational axis) of the parent galaxy. He also argues that these quasars start out as low-mass high-redshift objects and evolve over time to high-mass low-redshift objects. In 1997, Halton Arp, together with a team of Chinese astronomers, published a landmark paper: Quasars around the Seyfert Galaxy NGC3516. Arp refers to this system as the “Rosetta Stone” of Intrinsic Redshift. He says:

“We report redshift measurements of 5 X-ray emitting blue stellar objects (BSOs) located less than 12 arc min from the X-ray Seyfert galaxy, NGC 3516. We find these quasars to be distributed along the minor axis of the galaxy and to show a very good correlation between their redshift and their angular distance from NGC 3516. All of the properties of the high redshift X-ray objects in the NGC 3516 field confirm the body of earlier results on quasars associated with active galaxies. We conclude that because of the number of objects in this one group, the evidence has been greatly strengthened that quasars are ejected from nearby active galaxies and exhibit intrinsic redshifts.”

The graphic on the right of Figure-17 shows the evolution of a quasar that was ejected (birthed) by the parent galaxy. According to this theory, after ejection the quasar follows a path away from the parent galaxy. Its redshift decreases the further it gets from the nucleus of the galaxy. An important thing to note here is that the quasar redshifts appear to be quantized. (More on this later). At around 400 parsecs it slows to a stop. It then begins to fall back toward the parent galaxy where it begins its evolution toward becoming a companion galaxy of the host or mother galaxy. Redshift continues to decrease toward the redshift of the host.

Quantization of Redshifts

Tift was the first to investigate possible redshift quantization which he referred to as “redshift-magnitude banding correlation”. In 1973, he wrote:

"Using more than 200 redshifts in Coma, Perseus, and A2199, the presence of a distinct band-related periodicity in redshifts is indicated. Finally, a new sample of accurate redshifts of bright Coma galaxies on a single band is presented, which shows a strong redshift periodicity of 220 km s$^{-1}$. An upper limit of 20 km s$^{-1}$ is placed on the internal Doppler redshift component of motion in the Coma cluster".

In the standard model, redshifts are assumed to be caused by the recession of galaxies away from each other (due to the expansion of the Universe) and thus, redshift is a
measure of cosmological distance. As well, recessional redshift, in this model, points to the accelerated expansion of the Universe. The quantization of redshifts came as a big surprise to those whom originally observed them. They were not predicted by any theory including and especially the big bang theory. According to Arp, “If high redshift quasars are physically associated with low redshift galaxies, then redshifts cannot be interpreted as recession velocities.” Tifft’s redshift quantization theory also points to a non-velocity based interpretation of cosmological redshifts. These two theories together for all intents and purposes, falsifies the big bang theory.

The theory presented in this essay however, predicts a quantized region surrounding the nucleus of a black hole (centre of the galaxy). At the atomic scale, the quantization appears as the electron-shells and at the galactic scale, it manifests as the quantization of redshifts of quasars. Quasars then, according to my model are analogous to electrons.

**Gamma Ray Bursts**

In “QUASARS, GAMMA RAY BURSTERS AND BL LACERTIDS”, Arp also concludes that high redshift gamma ray bursts (GRB’s) are also closely associated with low redshift galaxies and even more so than for quasars.

“Like quasars, Gamma Ray Bursters (GRB’s) are high redshift objects which emit copious amounts of high energy radiation in their outburst phases. Recently a startling observation for which experts have no plausible explanation was reported. The new evidence shows that supposedly intervening galaxies are 4 times more prevalent along lines of sight to GRB’s than to quasars.”
This is an interesting and important piece of the puzzle with regard to my M-Set analogy. If GRB’s are even more closely associated with foreground galaxies, then GRBs can be thought to be closer to the nucleus of the galaxy than the quasars. In this manner, the GRBs would be analogous to neutrons and the “weak force” region in the M-Set analogy. Gamma radiation is a product of radioactive decay of atoms. Depending upon the ratio of neutrons to protons within its nucleus, a particular element may be stable or unstable. When the binding energy is not strong enough to hold the nucleus of an atom together, the atom is said to be unstable. Over time, the nuclei of unstable isotopes spontaneously disintegrate, or transform, in a process known as radioactive decay. The most common form of decay is known as beta decay. When an unstable atom ejects a neutron from the nucleus, the neutron (which is not stable when it is outside the atom) spontaneously ejects an electron (along with an anti-neutrino) and some gamma radiation. In my model, GRB events are analogous to radioactive decay or beta decay events.
Particle Dynamics and the Equivalence Principle

In general relativity, the equivalence principle states that local effects of a gravitational field are indistinguishable from those arising from acceleration, and vice versa. From this, it could be argued that extreme gravity (ie. Gravity near a black hole) should be indistinguishable from extreme acceleration like what you would see in particle accelerators. In other words, particle dynamics near a black hole should exhibit similar dynamics to that seen in particle accelerators.

Now, I will argue that the only way we can "see" a particle is via the bubble chamber pictures generated by smashing particles together in particle accelerators. We have never actually seen these accelerating particles directly, only via these bubble chamber pictures. In fact, what we are looking at when we look at these "pictures" are the "dynamics" generated by accelerating (smashing) these particles in the particle accelerators. Everything we know about these particles is inferred from the "pictures" generated by the bubble chamber experiments.

Given that, the equivalence principle states that accelerating particles in a particle accelerator is equivalent to “falling” or accelerating particles near a black hole, then we should agree that falling particles near a black hole should generate similar dynamics (or pictures) as the particle accelerator experiments. In other words, a bubble chamber device near a black hole should generate similar "pictures" as the particle accelerator bubble chamber experiments. In fact, this turns out to be the case as seen in this article from CERN$^{19}$. Black holes could act like cosmic particle accelerators. In order for the Mandelbrot Set analogous to a black hole, it should also be able to reproduce the dynamics of a bubble chamber pictures.
Figure-16 The above image demonstrates how particle dynamics emerge from the M-Set. The right side of the image was generated by following a set of points through the complex plane and plotting the trajectories of each of these points in sequence. Notice how much it looks like a bubble chamber image (on the left) which suggests that “particle dynamics” are somehow encoded into the Mandelbrot set.
Plancks Constant

All of the observables as described in the previous sections manifest via the iteration process of the Mandelbrot set iterated function system. Iteration is a recursive procedure where the output of the function is fed back into the function in a feedback loop or cycle. It encapsulates both a cause and effect. It is the smallest action that can occur in the system. Each iteration has equal value in that it requires exactly the same amount of “energy” (or CPU cycles) to execute. In this sense, it could be viewed as an action constant.

In my M-Set-Universe analogy, I equate iteration with energy and therefore mass and gravity, where an increase in iterations corresponds to an increase in energy or mass (and vice-versa). For the sake of this discussion, I will replace the word iteration with the word cycle where one cycle refers to one iteration. An oscillation is one or more cycles.

In M-Set, each test particle generates a unique set of cycles or oscillations. Equation (2) makes it clear that each cycle generates a new complex function. In this manner, M-Set can be thought of as a complex-function or wave-function generator, where each cycle generates a new (higher order) wave function. These iterative wave functions generate complex patterns or oscillations in the M-Set model. In standard cosmology, the term oscillation often refers to a small set of repeating patterns such as the back and forth motion of a pendulum or the cyclic oscillation of a clock. In M-Set, each point on the complex plane generates a unique and non-repeating complex oscillation. In this manner, M-Set can be seen as a “particle generator” where each point on the complex plane is associated with an unique test particle.

As seen earlier, the particles close to the event horizon take more cycles or energy to reach escape velocity. These particles are also much more complex than the ones farther away from the event horizon. In other words, heavier particle are more complex than lighter particles which is in complete agreement with observation. With is in mind, we will show how the action constant of modern physics, Planck's Constant, is related to the action constant of “cycle” in my M-Set model. To demonstrate this we go back to the original energy equation developed my Max Planck:

\[ E = hv \]  \hspace{1cm} (3)

which states that energy is equal to Plank’s constant \( (6.695 \times 10^{-34}) \) times the frequency (of light). The units of this energy equation are as follows:

\[ (J \times s) \times (\text{cycle/s}) \]  \hspace{1cm} (4)
where J is Joule and s is second. Second cancels (time cancels) and you end up with (J * cycle)
for the units of energy. For the sake of the M-Set analogy, I will stick to the old standard of
“cycle/second” as the units for frequency instead of “1/second “ or hertz as specified in the SI
standard, since the concept of “cycle” is intrinsic to the analogy as outlined in this essay. The
following is stated in the wikipedia page called Cycles per Second: “With the organization of
the International System of Units (abbreviated SI from the French) in 1960, the cycle per second
was officially replaced by the hertz, or reciprocal second—i.e. the cycle in 'cycle per second' was
dropped.” In this essay, I argue that the term “cycle” was arbitrarily removed from the standard
of units or SI units in 1960 thus preventing us from discovering and understanding a fundamental
property of light and matter. Since it was commonly known that the units of energy were J not
J*cycle, the units for frequency were set to 1/s thus removing the word “cycle” from the SI units
and indirectly from the language of theoretical physics.

However, a simple test can clearly demonstrate that (1/sec) is not equal to (cycle/
sec). By making the units of oscillation equal to 1/sec you are essentially setting cycle to 1. Thus,
(cycle x cycle x cycle) should also equal to 1 since (1x1x1) = 1 which is neither logical nor
mathematically sound. In “The Fundamental Physics of Electromagnetic Waves” (ref) Dr.
Mortensen recognizes this problem and makes a good argument for restoring the unit of
oscillation to the form cycle/s. She suggests that by removing the word “cycle” from the equation
and hence, the SI units, we were inadvertently eliminating an essential mathematical element
from the language of theoretical physics and possibly missing an opportunity to learn something
new about the nature of light and matter in the Universe. In this essay, I argue that “cycles”
belong in the energy equation and by setting cycles to “1”, we were inadvertently hiding the term
inside one of the other components of the energy equation, namely the kg or mass parameter of
the units of Joules (where units of J equals kg*m^2/s).

If we leave the term “cycle” in the energy equation we can then calculate (as Dr.
Mortensen did) the energy associated with one of these cycles:

\[ E = h \nu = a(Js)(cycle/s) \]  \hspace{1cm} (5)

{where \( a = 6.695 \times 10^{-34} \)}
s cancels and we end up with:

\[ E = a \times J \times \text{cycle} \]  \hspace{1cm} (6)

Now we can set cycle to 1 to find the energy of one cycle:

\[ E = a \times J = 6.626 \times 10^{-34} \text{ J} \]  \hspace{1cm} (7)
I contend that this is the true meaning behind Planck's constant; that the energy of one cycle is equal to or quantized to the above value (14). Notice how “time” has nothing to do with energy or Planck's constant in this treatment. In a later section, I argue that time is an emergent property of complex dynamic systems is therefore not a fundamental property of the Universe. Cycle, however is fundamental to both my M-Set model and the Universe. In this essay, I refer to iteration or cycle as the smallest action or action constant. Above (14) is an action constant exactly analogous to action constant in the M-Set model, where iteration or cycle is associated with energy and therefore mass. Using $E = mc^2$ ($m = E/c^2$), we can now calculate the mass associated with one cycle:

$$Mo = \frac{6.626 \times 10^{-34}}{c^2} = 7.372 \times 10^{-51} \text{ kg}$$

Mo is the mass of one “cycle” in the above treatment of the Plank's energy equation. It is a unit of mass, or the smallest mass. With this in mind, I argue that “cycle”, which was historically set to one to balance the units in the energy equation, was in fact hidden in and/or coupled to the kg or mass parameter in the units of Joules (kg*m^2/s). In this treatment, there are two components to the property of mass, intrinsic mass, Mo, and a cycle parameter or oscillation count Co where $m = Mo \times Co$.

This suggests that all particles, including photons, consist of one or more cycles or oscillations, where each cycle accounts for 1 unit of mass (where mass increases with increase oscillations). Note that all particles in our Universe, including photons, are often referred to as oscillators or harmonic oscillators so this idea therefore, does not contradict current theoretical models, it just exposes a previously unknown property of mass and energy. As this point, we are not really sure what cycle or oscillation “is” in the the real Universe. In my M-Set model, cycle is analogous to iteration, thus, I speculate that the Universe has a property isomorphic to iteration which leads to the emergent property of mass and therefore gravity. Light or photons are particles with few iterations or cycles and are isomorphic to the points on the outside of M-Set (that eventually reach escape velocity). Matter is associated with particles with many iterations and are associated with points from the inside of M-Set (that never reach escape velocity). Also I should point out that, although light is often thought to be massless, Einstein's energy equation (not to mention the photoelectric effect) shows that mass can be associated with light and therefore the above analogy doesn't not contradict the properties of light. In short, all particles that can reach escape velocity (or the speed of light) are associated with light or photons and all
particles that cannot and do not reach escape velocity are associated with matter.

Using this new fundamental constant, Mo, we can now calculate the number of oscillations associated with each particle. We will start by calculating the number of oscillations in the Planck mass where Mo = 7.372 \times 10^{-51} \text{ Kg} \quad \{\text{Intrinsic mass}\} \quad Mp = 5.45604 \times 10^{-8} \text{ Kg} \quad \{\text{Planck mass}\}

The number of oscillations in a Planck Mass Op is given by:

\[ Op = \frac{Mp}{Mo} = 7.401 \times 10^{42} \text{ cycles} \quad (9) \]

This turns out to be exactly the inverse of the Planck time at 1.351 \times 10^{-43} \text{ seconds}. In the above treatment of Planck's energy equation, “time” cancels out and we are left with the concept of cycle, which I argue is the true action constant associated with energy. As I discuss in a later section, time is not a fundamental property of the Universe but is an emergent property the the change associated with each iteration or cycle. It is unending non-repeating change that gives us the perception of time (see section called “Time as an Emergent Property” for more on this subject). In this manner, cycle is real and time is not, which is contrary to the standard model (where cycle is removed from the SI units and second is attached to the action constant). Planck time can now be interpreted as the time of one cycle or oscillation or the time of the smallest action or change. It is an action constant in the truest sense. It can also be thought of as the clock speed (of a computer) when expressed in terms of cycles at 7.401 \times 10^{42} \text{ Hz} \ (a \ very \ fast \ computer). I also want to point out that since the “second” is a completely arbitrary parameter calibrated for the human scale (along with meter and kilogram), then the Planck mass must refer to an arbitrary mass with little or no meaning with regard to the real world in that there are no fundamental particles in our Universe that have mass Mp, nor would I expect there to be any.

Now let us calculate the number of oscillations of an electron to see if these ideas are consistent with particles that we know to exist. Again, Mo = 7.372 \times 10^{-51} \text{ Kg} \text{ and } Me = 9.10938188 \times 10^{-31} \text{ Kg}

Number of Oscillations in a an electron:

\[ Oe = \frac{Me}{Mo} = 1.23567 \times 10^{20} \quad (10) \]

This is surprisingly close to the theoretical value of the Zitterbewegung of the electron (1.6\times10^{21} \text{ Hz}). The phenomenon of Zitterbewegung is described as a rapid fluctuation that happens to particles that are moving at relativistic speeds. These oscillations are thought to occur at the speed of light and the jitter is thought to be caused by particles that are in superposition between their matter and antimatter states causing the particle to vibrate (ref). Using this new interpretation of matter as outlined in this essay, I argue that this jitter is caused by a set of
complex oscillations resonating at the clock rate of the Universal computer. According to this analogy, particles moving as relativistic speeds would show an increase the number of oscillations since the energy is directly proportional to cycles or oscillations. This would explain why (16) is lower than the predicted value for an relativistic electron, since Oe would represent the Zitterbewegung for non-relativistic electrons. Increase velocity adds energy to a system, and, since energy is directly proportional to oscillation in my model, adding energy to the system is equivalent to adding oscillations. Although it is assumed that these oscillations (Zitterbewegung) are occurring at the speed of light, I argue that they are in fact occurring at the speed of time or in Planck-time and that the constant velocity of light is a direct result of the finite clock rate of the universal computer.

Speed of Light and Planck's length.

Using the speed of light and the new interpretation of Planck time, we can now calculate the distance light can travel in one cycle time, $2.99792458 \times 10^8 / 7.4 \times 10^42 = \sim 4.05\times10^{-35}$ which is exactly equal to the planck length. Planck length can now be interpreted as distance that light travels in one clock cycle of the universal computer.

Frequency, Wave Number and Intrinsic Mass

In the previous section(s) I argue that the concept of cycle should not have been removed from the SI units and that time is an emergent properties of change (and therefore not fundamental). I will now demonstrate that the other parameters (of the Universe), namely mass and length can now be treated in a similar manner to time in that they are also emergent properties of an intrinsic or fundamental event called cycle. Frequency refers to the number of oscillations per unit time and has standard SI unit 1/s to mean 1cycle/second. The term wave number refers to the number of complete cycles of an electromagnetic field and has units 1/m to mean 1cycle/meter. With this new treatment of the energy equation (13) we are able to calculate something (new) called intrinsic mass (Mo) to refer to the mass of one cycle or oscillation. I suggest that we can can now include a new unit in the SI units called the “mass number” with units 1/kg to mean 1cycle/kilogram. This produces a nice symmetry where cycles/second, cycles/meter and cycles/kg all have meaning (with 1/s, 1/m and 1/kg as units for each parameter). Currently 1/kg does not appear in the list of SI units. This approach also makes it very clear that the only thing that is “real” in our Universe is cycle. The second, the meter and the kg are all arbitrary parameters calibrated for the human scale in order for us to make measurements that
make sense at this scale. To conclude this section, I propose that time is an emergent property*, quantized by the time for one iteration or cycle, length (space) is an emergent property*, quantized by the distance light travels in 1 cycle and mass is an emergent property*, quantized by the mass associated with 1 cycle.
Entropy, Relativity and Evolution

In this essay, I argue that black hole event horizons are fractal in nature and that nature exists and persists at the event horizon of a black hole. All organized matter in the Universe tends to exhibit fractal patterns, and fractal patterns seem to occur spontaneously in nature. It is for this reason alone that I believe that the fractal nature of the Universe can be proven beyond a reasonable doubt. It is my contention that if one fractal exists in a system, then the whole of the system must be a fractal. If this turns out to be true, then there is no crossover to homogeneity in our Universe.

Spontaneous appearance of fractal patterns (in nature) seems to contradict the law of entropy which was classically interpreted as a “law of disorder”. However, as I will demonstrate below, entropy, and in particular, black hole entropy can be interpreted in such a manner that allows black hole event horizons to be a fractal. The Bekenstein-Hawking entropy equation (11) states that the entropy of a black hole is directly proportional to the surface area of the event horizon of the black hole:

\[ S_{\text{BH}} = \frac{A}{4} \]  \hspace{1cm} (11)

In order for entropy to increase over time (according to Newton’s second law), the area of the event horizon (of the black hole) must also increase. There are two ways for the surface area of a black hole to increase:

1) Increase the radius of the black hole.
2) Reduce the “measuring stick” of the event horizon.

In “How Long is the coast line of Britain, Statistical Self-Similarity and Fractal Dimension” (ref), Benoit Mandelbrot examines the surprising property that the measured length of a stretch of coastline depends on the scale of measurement. Empirical evidence suggests that the smaller the increment of measurement, the longer the measured length becomes. In other words, reducing the “measuring stick” increases the measurement. What do “measuring sticks” have to do with black holes?

\[ l_v = l_0 \sqrt{1 - \frac{v^2}{c^2}} \]  \hspace{1cm} (12)

One of the consequences of Einstein's theory of relativity is that measuring sticks
decrease, as one gets closer to the event horizon of a black hole (or as one accelerates toward the speed of light according to the equivalence principle). The above equation (12) clearly demonstrates this phenomenon. In Mandelbrot's fractal coastline theory, reducing the measuring stick increases the overall length/area/surface measurement. Now we can interpret the Bekenstein-Hawking equation in the following manner. From equation (11) we see that as entropy (of a black hole) increases, the surface area of the event horizon must also increase. Using Mandelbrot's fractal coastline theory, the measured length/area/volume can now be increased by reducing the measuring stick of the system.

In self-similar fractal geometries, like M-Set, fractal scaling is accomplished by reducing the measuring stick. This is how fractals are generally formed. In order to decrease a measuring stick, one must increase the resolution of the system. In order to increase the resolution of the system, one must increase the digits of precision of the system. This is equivalent to adding another bit to a computer processor or CPU. By adding more bits to the computer, not only are you increasing the resolution (digits of precision), you are increasing the “complexity potential” of the system. From this it can be argued that an increase in black hole entropy should bring about an increase in the complexity at the event horizons. In this manner, evolution would always tend toward more complexity in the vicinity of a black hole. Since evolution (on earth) does seem to increase in complexity over time, even after major extinction events, I argue that life exists, persists and evolves because the Universe is a 3-dimensional fractal curve bounded in four dimensions and that life (as a complex dynamical system) is an emergent property of the ever the increasing complexity of the event horizon, due to black hole entropy, over time.
Forces

In this essay I argue that all forces (in our Universe) are emergent properties of the non-linear dynamical system that generates our Universe. I also argue that the “laws of physics” are scalable and show how the equation of the coulomb force (between two charges) is self-similar to the equation for gravity (between two masses). In this framework, charge is analogous to mass (and coulomb analogous to kg).

In my M-Set model, forces (ie. Acceleration, angular momentum) manifests via the iteration process.

There is an inherent acceleration built in to M-Set ($z=z^2+c$) in that the squaring operation is equivalent to an acceleration (or force) in a system. In M-Set, squaring a large number accelerates the expansion of the system and squaring a small number accelerates the contraction of the system. Also, in the domain of complex numbers, the squaring operation imposes an additional rotation component to the system (in that multiplying two complex numbers equates to a rotation in a 2-dimensional space). In other words, the squaring part of M-Set combines the acceleration component and the rotation component into one operation. Thus, angular momentum comes for free in a complex iterative function system or M-Set. In our Universe, nothing exists that is not spinning, at some scale, from atom to dna to solar system to galaxy, galaxy cluster and the Universe itself; angular momentum seems to dominate in this Universe.

In our Universe, forces appear to behave differently at different scales. For instance, gravity as a large scale force only acts on large scale objects (gas giants, planets, suns), and electromagnetism as a small scale force acts only on small scale objects (electrons, neutrons, protons), yet these two forces have many self-similar properties such as the equation that governs these two scales. Also notice that smaller scale objects seem to spin faster than large scale objects. In other words, the faster something spins, the smaller the object is. This is referred to as conservation of angular momentum in the standard model.

A similar thing is seen in M-Set in that the “objects” at the smaller scale are considered to be spinning much faster, because they require more iterations to resolve (thus
increasing acceleration and spin). The increase in iteration at the small scale would also imply in increase in density due to the iteration-energy equivalence in my analogy. I also want to point out that the small scale regions (of organized patterns) in M-Set are actually closer to the event-horizon than the large scale regions or patterns (Figure 13).

Figure 13: This image is a zoomed in region of M-Set with a self-similar black hole identical to the original M-Set black hole. Notice the increase in iterations required to reach escape velocity. Also notice the increase in curvature of the white hole region at this scale.

In this essay, I postulate that our Universe is a 4-dimensional black hole surrounded by a 3-dimensional event horizon that we perceive as our Universe (generated by an non-linear dynamical system closely aligned with M-Set). From this I argue that the small scale objects in our Universe (ie, electrons, neutrons, protons) are in fact closer to the 4D black hole (of our
Universe) than the large scale objects. This explains the increase in density and smallness in size and increase in curvature (spin) at that scale, as would be expected for an object near a black hole according to general relativity. Figure-13 represents a small scale region of M-Set. Notice the increase in iterations the closer we get to the black hole. Also notice the increase in curvature as you look closer to the black hole region, indicative of space-time curvature around a cosmological black hole. (More evidence of the black hole nature of M-Set).

At the interface between the expanding part and the contracting part, we find an event horizon. This is where all the interesting “fractal patterns” are found. In a fractal universe, the self-similarity of all the forces can be explained, where, gravity, electromagnetic attraction and the strong force are self-similar manifestations of the contracting force (at different scales) and radiation, electromagnetic repulsion and the weak force can are self-similar manifestations of the expanding or radiating force (at different scales).

In galaxies, the central black hole represents the collapsing-contracting part and the region surrounding the black hole represents expanding-radiating (white-whole) part. When comparing an M-Set galaxy with a real galaxy (Figure-15) you can clearly see the self-similarity between these two “objects” indicative of a similar creation process.

**Figure 15 (a and b):** The image on the left represents a region of M-set centered on point (xx) with a range of (xx). The image on the right is the galaxy (xx). Notice the similarity in shape morphology of these two image. Although the M-Set galaxy is a bit contrived, compared to the real galaxy, I argue that this a) is what the Universe would look like without entropy and/or this is the idealized galaxy that the actual galaxy is striving to become over time (many iterations).
As stated earlier, I argue that the whole of the galaxy could be seen as the event horizon of the central black hole or nucleus. To be more precise, the whole of the galaxy consists of a 1) black hole, 2) a white hole and 3) an event horizon. I will hence refer to this as BH-WH-EH. These can be seen as three mutually exclusive yet interacting sets or fields. Using M-Set as my model, I speculate that black holes exist at many scales including the quantum scale within the boundary of the galaxy halo. We already know that there are stellar sized black holes and super-galaxy black holes. Since we already know that black holes are scalable, then it should not be a huge leap to find black holes at the scale of the atom. This can only be done if we are allowed to scale the “laws of physics” such that the forces can be seen as the same thing, only at different scales.

Along with the scalability of the system (BH-WH-EH), I am also proposing that there is a very specific scaling factor with which “organized matter” seems to appear. (By organized matter, I mean matter that follows the BH-WH-EH model.)

J. Hubbard and A. Douady proved that the Mandelbrot Set is connected. A connected set is a topological space which is not the union of two nonempty sets A and B for which both the intersection of the closure of A with B and the intersection of the closure of B with A are empty. In other words, it is a set with only one piece. In this discussion “Mandelbrot Set” refers to the set of all points (C) that cannot and do not reach escape velocity, or the black hole regions. If the black hole regions in M-Set are connected, then according to the analogy presented in this essay, black holes in our Universe must also form a connected set. That is to say that all black holes in our Universe are connected. If it turns out that atoms are black holes, as I am suggesting in this framework, then all atoms are connected thus explaining quantum entanglement.
Scalability of “Laws of Physics”

In a fractal universe, everything is scalable including the “laws of physics”. For instance the force equation for Newton's law is identical in form to the equation for Coulomb's law:

\[
G = (6.674 \times 10^{-11}) \text{ N m}^2 \text{ kg}^{-2} \quad \text{and} \quad K = (9.0 \times 10^9) \text{ N m}^2 \text{ C}^{-2}
\]

where the gravitational constant K is 20 orders of magnitude larger than G. These two forces are so far apart in scale that they for all intents and purposes have no effect on each other. I see this same effect in M-Set where the smaller scale “brots”, which are orders of magnitude smaller than the larger scale ones, appear to have similar gradients surrounding them. Figure-6 shows a large scale “brot” and Figure-5 shows a smaller scale “brot’ each with a very similar gradient pattern surrounding it. Notice that the points in the smaller scale gradients take more iterations to resolve than the points at the larger scales. Also notice that the smaller scale gradients tend to be more curved than the higher scale gradients. This is because the lower scale gradients are (for all intents and purposes) closer to the event horizon of the M-Set event horizon. In a similar manner, according to relativity, space-time curvature increases as you get closer to the event horizon of a cosmological black hole.

As demonstrated in Appendix (xxTBD), as one zooms into the event horizon of M-Set, what you find is the digits past the decimal place begin to stabilize from left to right. The more digits that are stabilized, the further you are zoomed into M-Set. The digits that have stabilized are what I associate with the coupling constant since they remain unchanged during the iteration process (a true constant by definition). Since it is constant, you can for all intents and purposes ignore it and see Newtons Law and Coulomb's Law as self-similar forces rather than different forces. In a similar manner, I argue that we should be scaling the coupling constant (down) when we are looking at larger scale objects such as galaxies. I argue that since the the coupling constant for the the coulomb force, which appears at small scales, is 20 orders of magnitude larger than G, then the coupling constant for galaxies, which appears at large scales, should be 20 orders of magnitude smaller than G, for example:

\[
B = 4.9 \times 10^{-31} \text{ N m}^2 \text{ kg}^{-2}
\]
where $B$ is the coupling constant for galaxies. In other words, the gravitational constant $G$ that we calibrated for this scale, doesn't not work on smaller scale objects such as atoms or larger scale objects such as galaxies. I argue that this approach could solve the illusive missing matter problem thus removing the requirement for dark matter. There is no missing matter; we are just using the wrong measuring stick and coupling constant.

The mistake made when looking at galaxies is that the sub gradients really have no effect on the main gradient related to the whole galaxy. Only the large scale gradient of the galaxy is responsible for the motion of the galaxy. The small scale gradient have no effect. In a fractal universe, the whole is greater than the part, therefore, you cannot count all the particles in a galaxy and add up all their masses and expect the galaxy to behave as if these particles are separate from the whole. Future work would be to calculate the coupling constants for galactic and galactic cluster scales.

**Scalability of Black holes and Event Horizons**

Figure (xxTBD) shows three M-Set “brots” at three different scales. The left one is the main or mother brot. The middle one appears at a somewhat smaller scale. The one on the right appears at the quantum level or the limit to the digits of precision of the computer used to generate these images. This series of image demonstrates the scalability of the M-Set black holes and event horizons. Black holes in our universe are also scalable in that we know that there are stellar sized black holes that are said to be created during supernova explosions. We also know that there are supermassive black holes at the center of all galaxies. Therefore, black holes (and event horizons) do appear at drastically different scales in our Universe.
Scaling Factor of the Universe

Here, I propose that not only is the organized matter in the Universe scale, but it has a very specific scaling factor of Phi (1.618) and phi (0.618). First, I propose that the Universe has a maximum size and that that size is inversely proportional to the Planck length, $1.616 \times 10^{34}$ meters. The next scale down ($34/1.618 = 21$) would be $\sim 10^{21}$ meters which is the approximate scale of our galaxy. Next scale ($21/1.618 = 13$) $10^{13}$ meters is the approximate scale of our solar system. The next scale ($21/1.618 = 8$) $\sim 10^8$. The radius of the sun is $6.9 \times 10^8$ meters. The next scale is $\sim 10^5$ meters which is the distance or radius of the biosphere of organized matter on this planet. Notice these scales fall on the Fibonacci sequence: 1,2,3,5,8,13,21,34…

More on the Phi relationship to the Universe and M-Set (TBD).
Fractal Cosmology © Lori Gardi

Fractal Time

In a fractal universe (a universe governed by complex dynamical systems), time can be seen as an emergent property of an ever changing system. It is the unending unknowable uniqueness of each moment that gives us the sensation of time. In a recent paper by Amrit Sorli\textsuperscript{24}, et al, time is described as a measurement of “numerical order of material change” in space: “With clocks, we measure only numerical order of physical events and the numerical order of change runs only in space and not in time.” Einstein also states that “time has no independent existence apart from the order of events by which we measure it.” Put simply, time is an emergent property of material change. A simple thought experiment can demonstrate the truth of this. If all the dynamics in the Universe were to suddenly stop, including the clocks, one can clearly see how time cannot exist without change.

Chaotic dynamical systems are famous for their ability to generate continuous material change over “time”. In computer generated systems, like M-Set, continuous change manifests via the iteration process. Each iteration of M-Set generates a new and unique complex number which in turn generates a new and unique complex number and so one. The sequence of numbers (generated by the iteration process) do not repeat (as shown in Appendix D), except at the limit to the digits of precision of the system when it reaches loop-singularity. This is the mechanism for continuous change in M-Set. In the black-hole region, the collapsing dynamic demonstrates continuous change. In the white-hole region, the expanding dynamic demonstrates continuous change. At the event-horizon, continuous change manifests as the complex dynamics.

A Universe as a complex dynamical system or iterated function system would generate continuous change in this manner. In such a system, the future is absolutely unknowable yet completely deterministic. The irreversibility of these dynamics would be perceived as the irreversibility of time or the arrow of time. Although there is an underlying cyclic nature to the Universe, each cycle brings about a different era, epoch or age. For instance, each cycle around the sun does not bring us to the same point in space the following year as our solar system is flying through space at some 200km per minute as we rotate about our galaxy and it rotates about the clusters and so on. Each year, we travel trillions of miles as we spiral our way through the Universe and we are never in the same place twice. Unending change is embedded into the complex space (or quaternion space) itself and emerges over time.

If time is an emergent property of an complex dynamical system (or change), then it
might also be fractal in nature. In this model, the fractal nature of time would manifest as “history repeating itself”. The sensation of “deja vu” might also be a kind of history repeating itself, only on a smaller scale. Also, it is not time that is repeating, the events are repeating. It is the sequence of events (and not time) that is self-similar and therefore fractal.
On Dimensionality

Space-time dimensionality developed by modern cosmology gives us a four dimensional space-time manifold with three dimensions of space and one dimension of time. Time is often referred to as the fourth dimension in modern cosmology, however, I will argue differently in this section. I agree with the premise that four dimensions are required in order for our Universe to exist. However, I propose that our Universe is a three dimensional (fractal) curve bounded in four dimensions. I also propose that time is the first dimension, not the fourth dimension and is associated with the real component of the complex plane not the imaginary component.

Quaternions are like complex numbers only they have one real component and three imaginary components (r,i,j,k). If quaternions were to be used to represent space-time, then the three imaginary components would represent the three dimensions of space and thus the one and only real component would represent a time or time-like dimension. Looking at Figure 1, it is clear that the real component (the vertical component) is time-like in that it does not have symmetry about the horizontal axis, whereas the imaginary component (the horizontal component) does have left-right symmetry (about the vertical axis). If I were going to assign time to a dimension based on the quaternion structure, I would choose the real component, not the imaginary component to represent time.
In order to help visualize a 3-dimensional fractal Universe bounded in four dimensions, let us look again at Figure 1. Notice that it takes a 3-dimension creature (us) to be able to visualize the 2-dimensional black hole that generates a 1-dimensional fractal curve. Now imagine a 5-dimensional creature visualizing a 4-dimensional black hole generating a 3-dimensional fractal curve that is our observable Universe.

More on space-time here.
Appendix A: Mandelbrot Set Algorithm

For each point \( C(Pr, Pi) \) on the complex plane \{ where \( r \) means real and \( i \) means imaginary \)
done = false
iterationCount = 0

//initialize point
Zr = Pr; Zi=Pi

while (!done)

  //iterate
  Z(r+1) = (Zr * Zr – Zi * Zi) + Pr
  Z(i+1) = (2 * Zr* Zi )+ Pi

  //replace previous Z with new Z
  Zr = Z(r+1)
  Zi = Z(i+1)

  //now test point
  if (Zr*Zr + Zi*Zi) > 4 //if point reaches escape velocity*

    //we can stop
    done = true

  else

    //the point has not reached escape velocity and therefore unresolved
    //we need to iterate one more time
    iterationCount += 1
    if (iterations > maxIterations)//stopping criteria
      finalIterations = iterationCount
      done = true

  //repeat while loop until done = true.
  //Here, done = true

  //First, we check to see if the point “escaped” before we reached maxIterations.
  if (finalIterations <= maxIterations)

    //here we can say for certain that the point escaped
    //paint the point a colour depending on iterations

  else

    if (iterations > max)

      //here we reached max iterations, point is not resolved
//paint the point black (figure 1b)
Appendix B: Method for Detecting Non-Escaping Points

Here, I describe a method for determining whether a point from the complex plane is a non-escaping point as iterated through the function (1).

```cpp
//Initialize point
bool done == false
previousPoint == -1000; //invalidate
while (!done)
    currentPoint = IteratePoint()
    if (previousPoint == currentPoint)
        done = true;
    else
        previousPoint = currentPoint;
//Here we have reached loop singularity
```

If the point is on the outside of Mset, then it will continuously expand and eventually reach escape velocity, so currentPoint and previousPoint will never be the same. If the point is on the inside of Mset, then the point will continuously contract and with an infinite number of digits of precision, would continue to collapse forever. However, all computers have a finite number of digits of precision and so the collapse of this dynamic is eventually stopped when two points “collide” when currentPoint == previousPoint. As stated in Appendix C, the digits of precision of a 64-bit computer is for all intents and purposes, identical to the Planck limit of \(\sim 10^{-34}\). This “flaw” in my computer is the reason these singularities stop the collapse.

Figure (xx) shows what happens to the digits of precision as they cycle through the function (1). You can see that the digits to the right of the diagonal line are continuously changing but the digits to the left of the line eventually stabilize. Once all but the last couple of digits stabilize, the iterative process begins to break down until finally, the last few digits form a cycle between one or more values. I refer to this as a “loop singularity” in that it is a singularity that eventually falls into a loop. Also, I would like to point out that the number of unique values in the cycle directly determines the number of “spiral arms” present in the singularity (Figure (xx)).
Occam’s Razor: is a principle urging one to select among competing hypotheses that which makes the fewest assumptions and thereby offers the simplest explanation of the effect.

The Mandelbrot Set is often thought of as a static object but as you will see, it is far from static. The dynamics is encoded into the system (equation+complex-space). In this sense, the complex plane can be seen as a state space or more accurately, an Invariant Set.


2. NOTE: the Mandelbrot Set generates a 1 dimensional curve with a fractal dimension of 2 which means it is a maximum space-filling curve.

Olbers’ Paradox: *Olbers' paradox*, named after the German astronomer Heinrich Wilhelm Olbers and also called the "dark night sky paradox", is the argument that the darkness of the night sky conflicts with the assumption of an infinite and eternal static universe.

Fractals: form, chance, and dimension, 1977

Standard cosmology models singularities with infinite collapse, however, the black holes we observe seem to have finite mass.

Note: the term "escape velocity" is the common term used to describe the behaviour of those points in M-Set, and is therefore the appropriate language for this treatment.

Wikipedia credit me with coining of the term Buddhabrot to refer to the points that are NOT in the set called Mandelbrot. Some call it the anti-mandelbrot set but, since there is no official term for these points, I will refer to them as the Buddhabrot Set.

Fractal Geometry of Nature: Benoit Mandelbrot

Black holes create their galactic halo. Ref.

IEEE standard gives ~34 digits of precision for a 64-bit computer although not all compilers and/or processors support it. AMD processors have on board support for this.

Note that you can represent numbers that are smaller (and bigger) in a computer using exponential notation, however, at whatever scale you are measuring, you will still only have 17 digits of precision (at that scale) on a 32-bit computer and 64 digits of precision on a 64-bit computer (theoretically).

Traditionally, the Mandelbrot set is display on its side with the real axis on the x-axis. In this essay, I choose to display the real axis on the y-axis such that the axis of symmetry is vertical.


Prochter, Gabriel E.; Prochaska, Jason X.; Chen, Hsiao-Wen; et al. 2006, On the Incidence of Strong Mg II

19 http://cerncourier.com/cws/article/cern/29520

20 Note that planck constants are usually calculated using h-bar where h-bar = h/2π. All of my calculations are done using the original Planck value of h.

21 Fields are sets of points. These three sets are by definition, mutually exclusive.

22 In this discussion “Mandelbrot Set” refers to the set of all points (in C) that cannot reach escape velocity. There is another set which I refer to as Buddhabrot and this is the set of all points that can and do reach escape velocity. Note: Wikipedia give me credit for coining the term Buddhabrot to represent this set of points.


24 The Biggest Misunderstanding of the 20th Century Science is that Time is a 4th Dimension of Space