Journal of Theoretics

On the Role of the Fractal Cosmos in the Birth and Origin of Universes

Harry A. Schmitz
5 Marwood Road South, Port Washington, New York 11050
hschmitz@sumnerrider.com

Abstract: A fractal model of the cosmos is presented in terms of distinct orders of universes, particles, substrates and strata. Each universe in the fractal cosmos is characterized by the radius of that universe divided by the effective radius of one of its stratum particles. It is shown that this size ratio increases rapidly for higher order universes and that a series of universes of descending order must terminate with the visible universe. The fractal cosmos is a single integral whole that gives birth to many generations of universes.

Introduction

The standard big bang model inevitably calls into question the origin of our universe within the cosmos and consequently rouses speculation about other big bang events besides the birth of the visible universe. It begs to be placed within an overall scheme of the cosmos. Fortunately, the structure inherent in a new model referred to herein as "the fractal cosmos" provides a complete framework for describing the births and origins of universes.

The fractal cosmos is presented in this paper as a speculative model because its application to astronomy and physics depends on detailed extensions beyond the scope of this paper. Nonetheless, its fecundity to generate many universes as well as many orders of universes merits consideration apart from its usefulness as a model of physical reality.

Fractals in Cosmology

The word *cosmos* as used in the phrase *fractal cosmos* means, of course, "the Universe that includes all universes." As such, the fractal cosmos is the setting for countless big bang events.

The idea that the visible universe is a small part of a much larger cosmos has been increasingly advanced in recent years. In the past two decades, investigators have studied a variety of models of inflationary universes, which are based on original works by Guth [1] and Linde [2]. A common attribute of many of these models is the hypothesis that the visible universe is the result of a quantum fluctuation within a chaotic cosmos, suggesting that an unlimited number of universes could be created in the same manner [3,4].

In another type of theory, using principles of general relativity, Smolin [5] speculates that the gravitational collapse of matter into a singularity might lead to the creation of a universe within the singularity. Presumably, a black hole in our own universe could distort space and time in a manner that is conducive to the creation of a new universe. The formation of black holes within black holes, each akin to a universe, is considered a possibility.

These models are courageous attempts to locate the big bang within the context of a larger cosmos. Smolin eloquently describes the challenge of confronting the possibility of multiple universes beyond our own, and he addresses the common complaint about these new cosmologies, i.e., the impossibility of peering beyond certain boundaries inherent in such models [6].

Like other new cosmologies, the existence of universes that cannot be directly observed is an attribute of the fractal cosmos. The author respectfully asks for the forbearance of the reader with regard to this situation until the model itself is fully understood. An argument to justify this apparent departure from the scientific method is given in the discussion section below, where an outline is also given for a program that could eventually validate the concepts presented here insofar as they pertain to our own universe.

In astronomy, a rather different application of fractals is their use to describe the distribution of galaxies in the visible universe [e.g., 7]. The fractal-like distribution of matter in our universe is completely different from the fractal-like structures in the fractal cosmos, and the two should not be confused.

The present paper advances a structure that allows for the development of an orderly sequence of universes. The fractal cosmos gives birth to many distinct fractal-like universes of different orders of magnitude. The fractal cosmos leads to hypotheses that distinguish it from the above theories. For example, one result is that our own universe can be assigned a specific rank within an hierarchical series of universes. It is granted that certain portions of the cosmos cannot be observed from our own universe; yet the fractal cosmos also requires the existence of certain well-defined phenomena in our own universe, and these features of our universe can be tested for agreement with experimental observations.

One well-known definition of a *fractal* is "an object that is self-similar on different scales." In the fractal cosmos, higher-order universes are not necessarily outside the realm of lower-order universes. Parts of the former can occupy the same space as the latter, similar to the manner in which small-scale features underlie large-scale features in common fractal forms. In other words, one particle can simultaneously exist inside many universes of different orders of magnitude. In this sense, the term *fractal* is especially fitting for this model of the cosmos.

Fractal Particles

A distinguishing characteristic of the fractal cosmos is the subtle relationship between particles and universes; hence, it is essential to briefly outline a model for fractal particles before the overall structure of the fractal cosmos can be described.

The structure of the fractal cosmos requires particles that are 3D standing wave patterns built upon smaller particles that are likewise 3D standing wave patterns. The idea of particles within particles leading to indivisible atoms dates back at least to the ancient

Greek philosophers but has not played a central role in modern physics. Yet, this idea is the *sine qua non* of the fractal cosmos, although in this case the “particles” are standing wave patterns.

Three-dimensional standing wave patterns with the symmetry of a sphere or cylinder can be expected to be stable within any order of fractal universe. Moreover, in such fractal particles, the core region can be emphasized apart from the remainder of the standing wave pattern. The effective particle size can be defined as the region bound by the innermost node of the standing wave pattern. (See Figure 1.)

Only the barest model of fractal particles is presented here. No attempt is made here to replace or duplicate other well-established particles models. Only the essential characteristics needed to construct the fractal cosmos at the first level of approximation are presented at this stage. Although it is not crucial to describe fractal particles in detail at this time, a deeper theoretical treatment of fractal particles at another time or by other investigators is not ruled out.

In any case, it should be mentioned here that the core region imparts particle-like behavior to the standing wave pattern by interacting with other wave patterns in a complex fashion. The principle of superposition of waves does not hold for the core region because the energy density of this core region reaches the maximum value allowable in the substrate. Meanwhile, the standing wave pattern surrounding the core region extends throughout the universe of its origin and imparts wave- and field-like behavior to the particle.

The description of particles as waves governed by the speed of light easily leads to a relativistic mechanics that is indistinguishable from the special theory of relativity of Einstein. A fractal particle essentially has built in rulers and clocks that exhibit the time dilation and length contraction of the standing wave pattern, in accordance with the Lorentz transformations, when the particle moves relative to another inertial frame of reference.

In addition, although beyond the scope of this paper, the interaction of fractal particles through the exchange of energy in wave packets suggests a physical basis for quantum electrodynamics and high-energy particle physics. Again, the intent is not to replace existing models but to only point out that the application of transformation equations, complex field equations and other methods of mathematical and theoretical physics to fractal particles could prove fruitful.

Actually, the fractal cosmos consists of *nothing but particles* in various interrelationships. Any universe within the fractal cosmos is, on a deep level, only a collection of particles. This paper will describe universes and substrates and so forth but actually the universes and substrates are merely representations of certain configurations of particles that are essential to the hierarchical structure of the fractal cosmos.

More will be said about fractal particles in the discussion section below but the description of particles given in this section is already sufficient for defining the overall structure of the fractal cosmos.

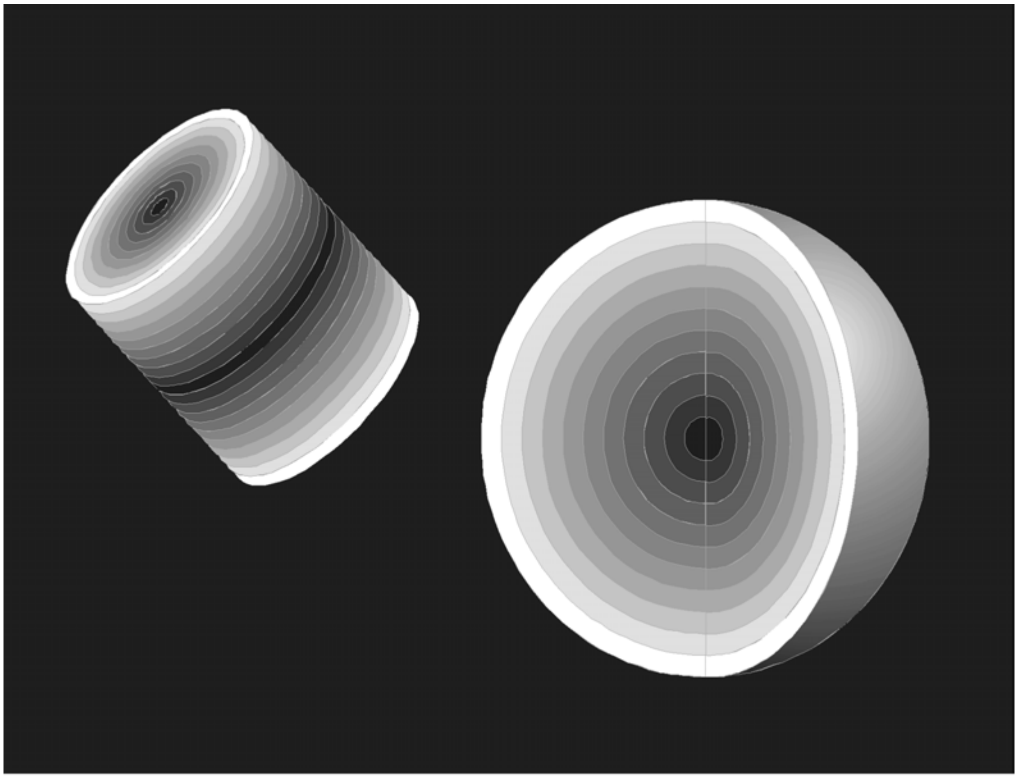

Figure 1. Nodal surfaces can be represented as lines in cross-sectional drawings of spherical and cylindrical standing wave patterns. A fractal particle can be taken as the region within the innermost node of the standing wave pattern.

Fractal Universes

Using the simple concept of fractal particles above, the major features of fractal universes can now be outlined. Figure 2 illustrates various orders of universes and particles and their interrelationships. Such a picture of an integrated structure of universes-within-universes and particles-upon-particles suggests that the components of the fractal cosmos are 1) fractal universes in the form of 1a) substrates and 1b) strata; and 2) fractal particles in the form of 2a) substrate particles and 2b) stratum particles.

A *fractal universe* is defined as either a substrate or a stratum, depending on whether it is viewed from the outside or inside, respectively. A *substrate* is defined as a super-dense solid sphere made of particles. A *stratum* is defined as all of the particles and wave patterns superimposed on a single substrate as well as all of the empty space or vacuum.

A *fractal particle* is a standing wave pattern superimposed on the smaller particles of the underlying substrate. A fractal particle has the properties described in the previous section. Generally speaking all of the fractal particles of one type within a fractal universe have the same size, wavelength and rest energy. These particles obey the laws of quantum mechanics. In our own universe, Planck's constant relates the maximum energy that can be transferred across a node during one cycle of vibration, as governed by the maximum-allowable energy density in the core region, to the frequency of vibration of the particle.

Stratum particles are more-or-less freely moving particles unless they condense into the substrate of a lower-order universe. *Substrate particles* are tightly packed in a substrate. They do not move freely or change nearest neighbors very frequently, although they can be highly energetic. They are more or less constrained to a relatively small volume within a substrate.

The simple concepts above unfortunately are unfamiliar to many readers. A close study of Figure 2 is useful for gaining familiarity with the definitions, and the next section uses our own universe as a familiar example.

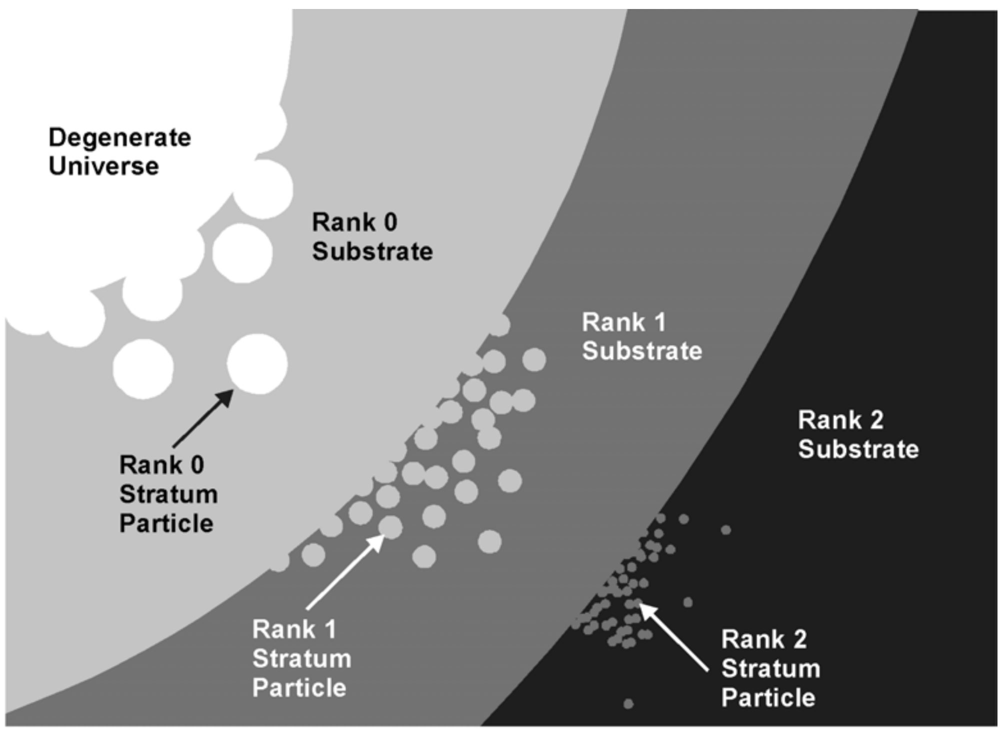

Figure 2. Three different ranks of universes and particles are depicted along with a degenerate universe, or neutron star. Although the different ranks of universes and particles cannot be drawn to scale on the same page, their interrelationships can be illustrated rather well. A consecutive series of universes of decreasing size can be built from a corresponding series of particles of increasing wavelength.

The Visible Universe

Also known as the visible universe, our own universe is without contradiction both a substrate and a stratum. The stratum of our universe consists of the objects of observational astronomy and experimental physics.

Yet, this familiar stratum is directly superimposed on a substrate that fills all of the space of the visible universe up to a distinct boundary. Astronomers have extended their observational capabilities of the stratum nearly to the surface of the substrate that underlies it.

Specifically, the stratum of the visible universe includes subnuclear and nuclear particles; photons, electrons, protons and neutrons; atomic elements, molecules, matter and living organisms; stars and solar systems; pulsars, neutron stars, quark stars, black holes, gamma-ray sources and quasars; and clusters of stars, galaxies, clusters of galaxies, superclusters of galaxies and cosmic background radiation.

The substrate of the visible universe is best understood in terms of a detailed analysis of the substrate particles. In quantum field theory, the substrate is characterized as a hypothetical quantum vacuum. It sets the stage for the big bang, the formation of stratum particles, and the eventual formation of lower-order substrates.

Size Ratio

An important characteristic of any universe is the ratio between the size of its substrate and the wavelength of its stratum particles. This dimensionless parameter varies widely for universes of different orders. Assuming that the radius of our universe is about 10^{26} meters and that the radius of a nuclear particle is about 10^{-15} meters, then the size ratio of our own universe is about 10^{41}.

It is useful to compare the size ratio of the visible universe with the size ratio of other universes in the fractal cosmos. An excellent object for comparison is a next-lower-order substrate, as represented by the neutron stars that can be observed in our own universe.

Neutron Stars

A neutron star represents the next-lower-order substrate compared to our own universe. Neutron stars, quark stars and black holes are interesting objects for physical and mathematical analysis and they are also instructional as degenerate universes, or pseudo-universes.

Neutron stars are commonly found within the remnants of supernova explosions. They are widely understood to consist of matter that has been compressed to a density of about 10^{14} grams per cubic centimeter, suggesting that the atomic structures have broken down and the nuclei are compressed one against another. As such, a neutron star is a good example of a substrate, in which a maximum energy density was reached by compressing substrate particles as far as possible under the pressures of gravity plus the implosion from the supernova explosion.

It is an interesting fact that all neutron stars are about the same size. The radius of a neutron star is about 10 kilometers. If any stratum particles were superimposed on a neutron star, the effective radius would be on the order of perhaps millimeters or kilometers. Assuming the neutron star is the same size as the effective radius of a particle in its stratum then the size ratio of a neutron star is equal to one. At most, a neutron star is only a few orders of magnitude larger than the wavelength of its stratum particles; and it is certainly only about 20 orders of magnitude larger than the wavelength of its substrate particles (i.e., neutrons or quarks). These ratios are small compared to the corresponding ratios for higher-order universes in the fractal cosmos.

A neutron star therefore is a pseudo-universe. Neutron stars are dead-end universes at the end of a long series of universe-producing universes. A richly diverse universe such as our own cannot be superimposed upon the substrate of a neutron star because of its small size ratio. A neutron star does not occupy enough space or contain enough stratum particles to produce new universes.

A Series of Universes

Just as the substrate of a neutron star is made of neutrons that are also stratum particles in our own universe so also the substrate particles of any universe are also stratum particles in a next-higher-order universe.

A fractal-like series of higher-order universes can be deduced by extrapolating from the relationship between a neutron star and our own universe, towards larger and larger fractal universes built upon smaller and smaller fractal particles. Each next-higher-order universe is characterized by a size ratio that is vastly greater than the size ratio for the universe immediately below it in rank. In fact, it is instructive to tabulate size ratios and other physical constants, even if only rough estimates, comparing neutron stars with our own universe as well as higher order universes. (See Table 1.)

Neutron stars play a special role as reference markers in defining the extent of the fractal cosmos. Since the fractal cosmos terminates at one extreme with neutron stars, universes can be numbered absolutely from lowest to higher orders. Assigning a rank of less than zero to a neutron star is fitting because a neutron star is not a universe.

Table 1: Orders of Universe and Size Ratios

Order	Name	Substrate (meters)	Particle (meters)	Size Ratio
None	Degenerate	10^{4}	$\sim 10^{4}$	$\sim 10^{0}$
0	Visible	10^{26}	10^{-15}	10^{41}
1	Penultimate	$\sim 10^{70}$	$\sim 10^{-30}$	$\sim 10^{100}$
2	Order 2	$\sim 10^{200}$	$\sim 10^{-50}$	$\sim 10^{250}$
N	Cosmos	∞	$1/\infty$	$\infty \cdot \infty$

∞ = infinity

Orders of Universes and Particles

Being just one order higher than a degenerate universe, our own universe can be assigned a rank of zero and called an *ultimate* universe (i.e., a final universe). Its size ratio of 10^{41} is more or less accurately known.

The universes one order higher than our own can be nicknamed *penultimate* universes (i.e., next-to-final universes). These super-universes can be extrapolated to have a size ratio of perhaps 10^{100} and assigned a rank of 1.

Branches of universes converge extremely rapidly. A fifth-order universe has features that are as close to infinity or zero as required for practical purposes. The order of a universe has a dramatic effect on its scale, which can be appreciated by estimating orders of magnitude for important parameters in third- or fourth-order universes.

As a matter of convention, particles should be assigned the same rank as the universe of their origin, regardless of whether or not these particles are involved in the substrate of a lower-order universe. Consequently, a stratum has the same rank as its individual stratum particles; stratum particles have a higher rank than any new substrate that they might form; and substrate particles considered individually have a higher rank than the substrate as a whole. As an example, the neutrons in a laboratory and those in a neutron star both have a rank of zero.

A universe can be represented from the outside as a substrate or from the inside as stratum; in either case, that universe is assigned the same rank. In other words, "stratum plus substrate" equals "substrate plus stratum," and both represent one universe.

Another way to envision the structure of the fractal cosmos is through an exploded view of its universes. The order of any universe in such a "family tree" is determined by its relative position with respect to a neutron star. (See Figure 3.)

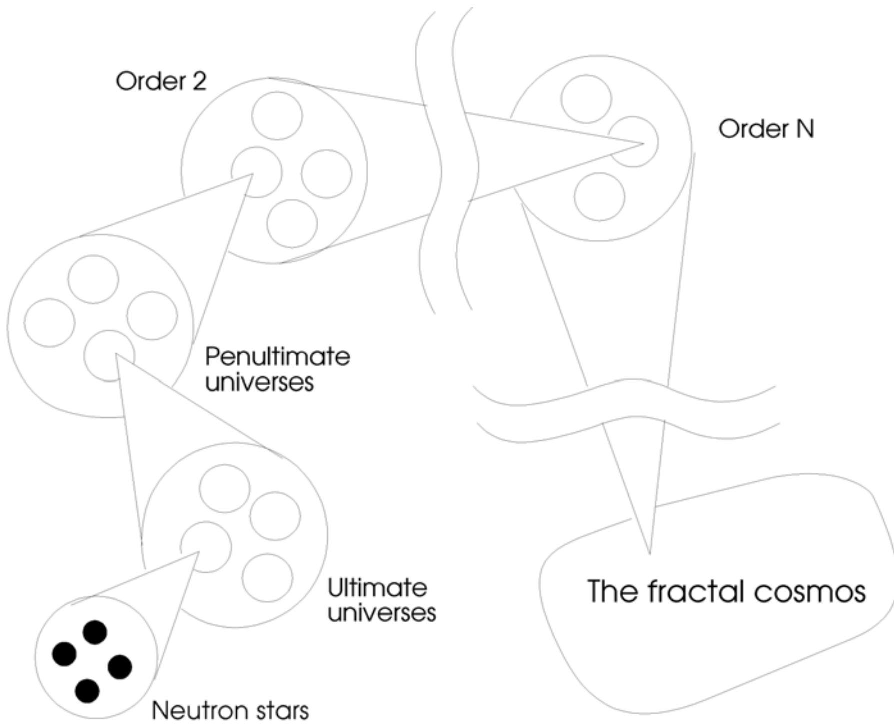

Figure 3. This exploded view shows the fractal-like structure of the cosmic manifold, which terminates with degenerate universes at one extreme and the whole cosmos at the other. The simplest numbering system begins with zero for a universe that contains degenerate universes in its stratum. Increasing numbers are assigned to intermediary universes up to rank-N for the highest order of universe under consideration.

The Whole Fractal Cosmos

The fractal cosmos as a whole is simply the highest order of universe under consideration or the highest order of universe that can be imagined.

The fractal cosmos itself is the earliest universe and includes all subsequent universes. It is the oldest universe in any series. The fractal cosmos existed prior to all other universes and is the origin of all universes. The particles of the highest-order universe are the simple substance of the entire cosmic manifold. All lower-ranked universes are simply arrangements or patterns of these underlying particles. In other words, all universes are contiguous with the basic particles of the whole cosmos.

The highest-order universe of the fractal cosmos is effectively the cosmos itself. Practically speaking, the highest-order particles have an infinitesimal wavelength and they are packed together at an infinite density. Yet each particle extends wave-like through an infinity of space. This structure is philosophically interesting with regard to the well-known antinomies of reason of Kant [8].

Amazingly, as proven by the existence of our own universe, which is an ultimate universe, the progressive creation of universes has already been going on for eons and the end of the series has been reached already.

Discussion

To portray the birth of our universe as a big bang is like describing the birth of a living organism without mentioning the origin of the species. The search for the origin of universes currently is one of the most exciting activities in science. The discovery of the initial conditions conducive to a big bang event would set the stage for the future of cosmology as a genuine science, and a complete theory for the origin of universes would rank as one of the greatest triumphs of humanity and reason.

Psychologically, the most challenging aspect of the fractal cosmos to grasp is the implication that our universe exists in the interior of a dense solid substrate of finite dimensions. This vision of our universe may appear to run contrary to perceptions of bodies moving freely through infinite space. Nonetheless modern theories of fields and particles as well as astronomical observations do not rule out the possibility that atoms exist as waves superimposed on an underlying substrate.

This presentation has been kept as simple as possible in order to communicate the ideas to as broad an audience as possible. Rigorous comparisons with established theoretical and experimental results are vital for the fractal cosmos to be useful in scientific investigations. Physicists can verify whether or not the fractal cosmos is workable as an accurate representation of physical reality but much work needs to be done. Further analysis and observation might even lead to startling new predictions and discoveries.

The most important part of this discussion is to outline the methods by which the present model can be validated or refuted. As mentioned previously, it is granted that there are universes that can never be observed from within our own universe. However unfortunate this situation may appear to some critics, it does not preclude certain detailed investigations of the fractal cosmos. Paleontologists can study fossils and state with certainty that dinosaurs once walked on the earth, yet no human being has ever observed a living dinosaur. Stated generally, assume that A and B are essential components of a model but only A can be directly observed. If A strongly implies B one can be confident about the existence of B without ever directly observing B. In this manner, the author offers some justification for the development of a model that implies the existence of phenomena that cannot be directly observed.

To validate the model, it is necessary to concentrate on predicted phenomena that can be validated by observation. Fractal particles especially merit further investigation. The first step in a program to validate this model would be to elucidate the properties of fractal particles. The next step would be to compare their predicted behaviors against validated laws and principles, including Maxwell's equations, Einstein's special theory of relativity, quantum electrodynamics, general relativity and other cornerstones of modern physics. It has been briefly noted above that fractal particles behave in accordance with the special theory of relativity.

The present theory does not replace quantum field theory any more than it replaces classical physics. Nonetheless, the existence of a maximum limiting pressure (or maximum energy density) in the substrate of our universe, and hence at the core of the 3D standing wave patterns of fractal particles, provides a basis for extremely complex particle interactions, especially at short ranges and high energies. Computational techniques eventually *might* be developed that will allow precise calculations of the strength and directions of the interactions between fractal particles. Initial investigations appear promising.

Also, the limitations in the rates at which energy can be transferred between adjacent wave shells of a fractal particle suggest quantum phenomena. Energy is transferred across the nodes of the wave pattern in accordance with the basic frequency of oscillation of the standing wave pattern. The maximum energy that can be transferred between adjacent wave shells during one oscillation can be equated to $h\nu$, where h is Planck's constant and ν is the basic frequency of vibration of the particle (i.e., electron or proton).

The decreasing cosine-like distribution of pressure (energy per unit volume) around a particle is a new quantity. It should not be mistaken for electric potential, gauge potential or the quantum probability function. However, it should be possible to derive these latter quantities (including the strong, weak and electromagnetic forces) from sufficiently advanced models of fractal particles and their interactions.

The energy in each spherical shell surrounding the core of a spherical standing wave, for example, must be equal to the energy of pressure times the volume of the innermost core. When the core of a proton is located in the shell of another proton it redirects a portion of the energy from that shell. The manner in which this energy is redirected determines the repulsive force between the two protons, and the relationship between kinetic energy and velocity determines the mass of the proton.

An electron requires less kinetic energy than a proton to move at a given velocity. Initial investigations suggest that an electron is a cylindrical standing wave, which can move relatively easily along its axis compared to a proton; and that a proton has the form of a spherical standing wave. These are the only two stable 3D standing wave patterns so other particles in the standard model are probably different energy states of these same basic patterns.

This cursory outline obviously does not present a complete theory for the interaction of fractal particles. It is only meant to suggest that such investigations could prove fruitful and a robust theory could be developed over time. Each of the above tests would require mathematical models, and the author makes no guarantees that calculations based on such models would yield results to the same accuracy and precision as the tremendously successful theory of quantum electrodynamics. Calculations may even prove intractable. The point is that the above model is well defined. We can ask how fractal particles would interact in any fractal universe, and if the patterns of interaction mimic actual experimental and theoretical results then a good portion of the fractal cosmos can be considered validated.

Other points of correlation with the physical universe would be the ability to account for the Hubble expansion of space and the cosmic background radiation. Progress in theory here would require an understanding of how the implosion of particles in an order-

1 universe would lead to an excess energy within the substrate underlying the visible universe. It would be necessary to determine how this energy would eventually be redistributed among identically sized protons and electrons in the atoms that define our existence.

Another remarkable hypothesis can be advanced here. It is possible that energy can be lost through the boundary of the surface of a fractal universe. Hypothetically, each atom is losing energy through the surface of the substrate of its origin. The reflection of energy from the surface might account for the cosmic background radiation; and it might also account for gravitational attraction, because the normal energy loss through the surface is hindered by interposed particles. The extremely slow rate of this loss would account for the weakness of the gravitational force compared to the electromagnetic force.

Once these features of our own universe can be interpreted in terms of the fractal cosmos, it may be possible to correlate additional astronomical observations with the model, including galaxy formation, quasars and gamma radiation bursts.

As the reader may have surmised already, the fractal cosmos raises many more questions than can be adequately addressed in one article. A complete development of this model of the fractal cosmos could provide explanations for a variety of physical and astronomical phenomena that have hitherto defied explanation. This paper is not intended to answer every question raised by the fractal cosmos. Nonetheless, these brief remarks are offered to point out that there are numerous ways to test the validity of the fractal cosmos as an accurate model for our universe.

If the fractal cosmos should emerge validated as a model for the visible universe then it would also be necessary to concede the likelihood of the existence of an entire series of universes in a fractal cosmos, as described in the main section of this paper. Theoretical models can be developed for higher order universes but the strength of conviction in their validity still lies in the degree of correspondence between the fractal cosmos and experimentally observed phenomena in the visible universe.

Summary and Conclusion

This paper postulates new fundamental relationships between particles and universes. A 3D fractal-object of remarkable beauty was constructed using a few simple geometrical ideas. The fractal cosmos is elegant in its simplicity yet powerful in its application. It merits further study to test the limits of its application to physics and cosmology.

The fractal cosmos unifies the infinities of space, time and substance in a single, integrated, infinite fractal geometry. The essential correspondence between particles and universes can be called *the Fundamental Principle*, which can be stated in a various ways. Some examples are as follows.

- Particles-upon-particles are fundamental to universes-within-universes.
- A hierarchy of particles makes up a hierarchy of universes.
- A particle-manifold underlies a cosmic manifold.

The order of any universe indicates its relative size compared to our universe and also determines the characteristic wavelength of its particles. For lower-order universes, the particle wavelengths are longer and the universes are smaller. Conversely, particle wavelengths are smaller and universes larger for higher-order universes.

In order to test the validity of this model, fractal particles especially merit further investigation. The major thrust of physics in the twentieth century was to characterize particles in terms of wave patterns. The successful explanation of experimental observations in terms of particles, waves and fields, culminating in quantum field theory, was *the* great triumph of twentieth-century physics. Therefore, the hypothesis that fractal particles are 3D standing wave patterns rests on a firm foundation, but there is much more to learn about fractal particles.

This emerging paradigm synthesizes many well-accepted concepts of modern physics, astronomy and cosmology. It is beyond the scope of this paper to explore the implications of this emerging paradigm for the various branches of science, philosophy and the humanities.

Acknowledgments

Many of these ideas originated more than 50 years ago with Harry Walter Schmitz (1923-1979). HWS served in the U.S. Army 12th Armored Division from December 1944 to May 1945 in France and Germany and was awarded the Bronze Star. He was graduated from Syracuse University in 1949 and worked as an engineer for the next 30 years obtaining eight patents. During that period, in his spare time, he extended and tested the fundamental principle against the theories and experimental results available to him. He left behind a considerable body of notes, including a remarkable treatise summarizing his major results.

HWS first attempted to teach his radical ideas to me approximately 30 years ago. My contribution here has been to simplify the model in part by describing the fundamental principle in terms of a fractal object. I am grateful to David Schmitz for his artistic rendition of several key concepts.

> "It would be much more preferable to have a conflict in understanding reveal a fault in the concepts, rather than to have the conflict exist because of a misinterpretation of the full nature and scope of the concepts."
>
> — Harry Walter Schmitz, Glens Falls, New York, 1975.

References

1. Guth A.H., *Inflationary Universe: a possible solution to the horizon and flatness problems*, Physical Review D **23** (1981) 347.
2. Linde A.D., *Scalar field fluctuations in the expanding Universe scenario*, Physics Letters B, **116** (1985) 335.
3. Linde A.D., Linde D. and Mezhlumlan A., *From the Big Bang theory to the theory of a stationary Universe*, Physical Review D **49** (1994) 1783.
4. Winitzki S., *The eternal fractal in the universe*, gr-qc/0111048/.

5. Smolin L., *On the fate of black hole singularities and parameters of the standard models of particle physics and cosmology*, gr-qc/9404011/.
6. Smolin L., *The Life of the Cosmos*, Oxford University Press, Oxford and New York, 1997, ch. 7.
7. Joyce M., Anderson P.W., Montouri M. and Sylos Labini F., *Fractal Cosmology in an Open Universe*, astro-ph/0002504/.
8. Kant I., *Immanuel Kant: Prolegomena to any future metaphysics that will be able to come forward as science / translated and edited, with an introduction, and selections from the Critique of pure reason, by Gary Hatfield*, Cambridge University Press, Cambridge and New York, 1997.

Journal Home Page