A GALILEAN MULTIVERSE?
A SIMPLE PHYSICAL MODEL OF A FRACTAL COSMOS

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ABSTRACT

A new model of a cosmos with hierarchical Universes depends on the existence of three-dimensional (3D) standing wave (SW) patterns of various ranks. Various aspects of this model are explored, both qualitatively and quantitatively, using simple geometries and simple physical concepts. The number of particles in our Universe is shown to equal the square of the ratio between the radius of the Universe and the effective radius of a particle. It is shown that a series of Universes terminates with our visible Universe.

INTRODUCTION

When my father Harry W. Schmitz (1923-1979) described the present radical "theory of the Universe" to me by in the mid-seventies, there was no mention of fractals. That's not surprising, because Mandelbrot's seminal book, **The Fractal Geometry of Nature**, was not published until 1977 [1]. When re-examining this theory a few decades later, in the late nineties, I discovered that it could be described quite nicely in terms of a fractal object. In other words, our Universe can be modeled as an object that is self-similar on different scales.

To describe this simple physical model of a fractal cosmos, I am going to sketch out the necessary properties of what I call 'fractal particles'. If I can get across the idea of fractal particles, then I can make the conceptual leap to the big picture of the fractal cosmos (FC).

MULTIVERSES

This fractal cosmos is distinct from the various 'multi-verses' that have infiltrated mainstream science in recent years. Not long ago, multiverses were regarded as idle speculations; but now, for whatever reason, it is no longer considered heretical to speak of them. To my knowledge, there are two main classes of multiverses: the 'eternal inflation' (EI) multiverses of Andrei Linde [2] and others, which are based on quantum field theory (QFT); and the 'black hole within black hole' (BH-within-BH) multiverses of Lee Smolin [3] and others, which are loosely based on general relativity (GR).

Each of these types of theories has its shortcomings. The EI theories say a lot about particles but very little about substrates. Meanwhile, the BH-within-BH theories say a little about substrates and almost nothing about particles. Furthermore, in these theories, there is no compelling reason for any given Universe to be much different from any other Universe.

SUBSTRATES AND STRATA

This simple physical model of a FC does not depend on QFT or GR. It can be described in terms of a simple nomenclature, which includes different ranks of Universes and particles within a single integrated fractal object. The Universes can be viewed as either substrates or strata. And particles can play the role of substrate particles or stratum particles.

A simple illustration shows the big picture of the FC (Figure 1). But a deeper understanding of particles is imperative to fully appreciate the cosmos as a whole. For the fractal cosmos to exist, it is necessary to have fractal particles that are three-dimensional standing waves (3D SW's).

FRACTAL PARTICLES

Milo Wolff already has done a terrific job in exploring 3D SW's. He presented at a past meeting of the Natural Philosophy Alliance [4], and several of his papers can be found in past issues of *Galilean Electrodynamics* [5,6] or on the Web [7]. Wolff has done a credible job of showing that 3D SW's can account for many physical properties of electrons, and also account for the experimental results associated with special relativity.

My father also described particles as 3D SW's. There is a detailed description of these 3D SW particles in his treatise [8]. He visualized these particles quite clearly as pressure waves superimposed on a substrate that he referred to as a 'pulsar space'. The substrate is composed of much smaller particles that are themselves 3D SW's superimposed on a much larger substrate.

There is nothing very mysterious or mystical about these particles. They are much more concrete and unequivocal than the particles that are defined by quantum field theory. They are simply 3D SW patterns. The incoming wave bounces at the center and becomes the outgoing wave; the outgoing wave bounces from the inside surface of the substrate and becomes the incoming wave. The quantity that is undulating is the energy density or (equivalently) the pressure.

What makes these particles special is that at their center the underlying substrate reaches a maximum pressure. The substrate cannot be compressed any further than it is at the core. This limiting pressure is the key to particle interactions. If it weren't for that limiting pressure, there would be no particle interactions, because one could linearly superimpose one wave on top of another.

INITIAL MOMENTS OF PULSAR

Substrates form through processes analogous to the formation of a pulsar or neutron star during a supernova event. A cloud of particles condenses. If the gravitational pressure (or weight of the mass pushing in) exceeds the thermal pressure (or the kinetic energy pushing matter out), then the collapse is very sudden. But, the cloud mass does not collapse into a black hole. Matter and energy are blown away as long as the maximum energy density (or maximum pressure) is present throughout the star. If the maximum amplitude of the 3D standing waves is defined as P_0 – and the baseline pressure also is P_0 – then this maximum pressure is equal to $2P_0$.

Eventually as matter and energy continue to be blown away the pressure begins to drop below $2P_0$ starting near the surface until a cosine distribution of pressure is formed from the center to the surface at $r = R_0$. At that point, simple harmonic motion begins. The substrate alternates between one state of maximum potential energy due to pressure (at which time a maximum pressure of $2P_0$ exists in the center) and another state of maximum potential energy due to gravity (at which time the pressure is 0 at the center).

Initially, there is one large SW pattern. It is well described in Chapter 2 of [8]. The total reversible energy of this initial wave pattern is proportional to the cube of the radius of substrate.

COSMIC ARITHMETIC

This reversible energy can come to be distributed among many particles. The pressure in the core of these particles also is limited to $2P_0$ and the standing wave oscillates between a maximum pressure of $2P_0$ and a minimum pressure of 0. The core region of these particles has an effective radius of r_0 and the 3D SW pattern has a wavelength of $4r_0$.

There is some debate about whether this core region should have an effective radius of r_0 or $2r_0$. In the latter case, it would nicely fit an analytical solution of the wave equation in spherical coordinates [5]. A resolution of this question is not critical to the general description of the fractal cosmos but it is important for detailed calculations. H.W. Schmitz used r_0 as the effective radius in his calculations [8].

The ratio of the initial energy of the entire Universe to the energy in the core of a single nucleon is $(R_0 / r_0)^3$. Now, the total energy of a nucleon is R_0 / r_0 times the energy in the core (because the energy in adjacent spherical shells must be equal). Therefore, the number of nucleons in the Universe can be approximated as $(R_0 / r_0)^2$. Milo Wolff arrived at the same equation, which he calls the cosmological equation, although he derived it using a different approach [7]. For our Universe, that number is approximately $(13 \times 10^{25} / 6.6 \times 10^{-16})^2 \approx 4 \times 10^{82}$.

It is interesting to note, by the way, that if these 10^{82} nucleons were compressed to the densities associated with a neutron star, they would fill a sphere with a radius of about 2500 million kilometers – which is about the orbital radius of Uranus.

THE BIG PICTURE

The concept of a fractal particle and the concepts of a substrate and stratum can now be put together in a fractal cosmos. Figure 1 shows our own Universe as a rank-0 Universe, which has a radius R_0 equal to 13.7 billion light years (13×10^{25} m).

It is noteworthy that one cannot form a Universe on the substrate of a neutron star [9]. The substrate particles – which we can call nucleons or neutrons – are too large. Any particle superimposed on the substrate would need to be macroscopic in size. Yet the substrate is only 10 kilometers in radius. Therefore, the series of Universes terminates. Our fractal series has an end! That's why I call our own Universe an ultimate Universe or a Universe of rank zero. It is at the end of the series. I don't think that any other multiverse model draws that conclusion.

To recapitulate, I am maintaining that the nucleons (or substrate particles) in a neutron star retain their own identity just as protons in a glass of water do. Each of these nucleons extends to the surface of our own Universe.

The visible Universe, or the Universe of observational astronomy, which contains galaxies, solar systems and so on, is composed of stratum particles superimposed on a substrate that is about 13.7 billion light-years in diameter. Each nucleon is a standing wave that fills the whole Universe. The incoming wave is actually a reflection from the inside surface of this Universe.

THE PENULTIMATE UNIVERSE

So, one might ask, "What about the penultimate Universe?" It has a diameter vastly larger than our own Universe, say 10^{70} m; and its particles are much smaller than our own particles. Let's say that its particles have an effective radius of about 10^{-30} m.

Long ago within that Universe a cloud of its particles condensed to form a huge substrate with a radius of 10^{26} meters. These numbers are staggering.

How many nucleons are there in a penultimate Universe? There may be 10^{200} nucleons (*i.e.*, $10^{70-(-30)}$ squared). Our own Universe might contain 10^{168} (*i.e.*, 10^{56} cubed) of these particles, and there may be 10^{30} Universes like our own in that penultimate Universe. If that's not staggering enough for you, just consider the $n = 2$ Universe!

The point here is not to count to infinity but to appreciate that we have an integrated fractal object that connects these Universes. Possibly this series of Universes converges very quickly to a kind of infinitely simple substance, which actually underlies our own space. We are, in a sense, in intimate contact with these various higher-level substrates. So, the fractal cosmos is not about energies that are remote and can never affect us, but it is about the physical nature of our existence or natural philosophy.

DISCUSSION

I like to think of this simple physical model of the FC as a 'discovery' because, more and more, I am beginning to believe that the FC is a fundamental mathematical object. It is deceptively simple in the way that the number line is deceptively simple. The number line with its natural numbers, integers, rational numbers, real numbers, and complex numbers has challenged and inspired many of our greatest mathematicians. Yet, it can easily be taught to first graders.

In the same manner that the number line is the foundation for much of mathematics, I would like to boldly propose that the FC rests at the foundation of natural philosophy. The inductive aspects of the FC are especially intriguing. As far as I know, in other systems of multiple Universes, a Universe of rank n may as well be the same as a Universe of rank $n+1$. There is nothing to differentiate these Universes into a hierarchy. In the fractal cosmos, a hierarchy of Universes is a necessity. In other words, *n* does not equal $n+1$.

Therefore, in the same way that inductive proofs are used in number theory, arguing from the cases for n and $n+1$, and so on to infinity, the fractal cosmos can be used to count Universes and particles, and investigate their properties.

CONCLUSION

What this all means philosophically should be very interesting. From a natural philosophy point of view there is a lot of motivation to work out a theory for the 3D SW's. For one thing, absolute velocities can be defined in our own Universe relative to surface of the substrate upon which it is superimposed. That simple fact has important implications for special relativity.

In addition, I think that a physical basis for particle interactions can be found in terms of fractal particles. The pressure waves around a particle should *not* be viewed as an electrical field, electric potential or a vector potential. The electric potential must be derived from the energy differences that occur when the core region of one particle moves within the waves of another. The direction of the force has to do with how that energy is absorbed or transferred into the wave pattern. That is not an easy task but it is not unsolvable either.

In conclusion, I would like to encourage those who have an interest in electrodynamics or nuclear particle interactions to use the features of 3D SW's as a guide in the development of their models. I hope that more people will give some thought to this fractal cosmos.

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