Modern Cosmology: Building a better container for the human soul

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The King James Bible offers barely 700 words (mostly in Genesis) out of nearly 700,000 words about the so-called physical world or its various phenomena and properties. Occasional scattered references to the sun, moon and their cycles, or comments about earth, fire, air and water can be found if you are prepared to look for them in such a massive document. With so few words to study, especially in their original languages, most discussions about the 'deep physics' in the Bible reduce to semantics, matters of traditional interpretation, and deductive inference.

Original texts for Biblical chapters do not exist, unlike the copious documents we have from other ancient literary sources chiseled into tomb and temple walls, or on clay tablets. The exact time and place of most, if not all, Biblical writings, are speculative or controversial, and the authors of specific writings such as Genesis 1:1 to 2:6 (Priestly : P Document) and Genesis 2:7 to 2:25 (Jahwist : J Document) are nameless (e.g. Metzger and Coogan, 1993). Apparently, we cannot factually determine whether Biblical passages were written by single inspired authors, groups of individuals, or in what ways they have been edited to appear in the current form. Presumably Old Testament writings, nominally written or edited by Moses himself, were subject to the same level of editing as for instance the New Testament canonical texts before and after the First Council of Nicae ca 325 AD, but we can never know for certain.

Irrespective of the origins of the sacred words themselves, what we do know is that the descriptions of the physical world that appear throughout the Bible, taken at face value, are consistent across many civilizations with the common-knowledge definitions of the terms in use thousands of years ago. It is for this reason that many of our current 'intuitive' understandings about our so-called physical worlds are in serious need of revision.

Building an Old Body from Old Ideas.

The Physical World, in the broadest sense, is equivalent to the terms Natural world or Material world. It ranges in scale from the subatomic to the cosmic. It represents all of the tangible, measureable, and manipulable elements of our existence. It is the popularly-understood domain of scientific research.

Most of the terms used today in colloquial discussions about the physical world have been in use for more than 100 years; many are found among the earliest known human writings. The following terms have well-known 'common sense' definitions. The definitions are intuitive, which means they are compelling. They are also extracted verbatim from a popular physical science textbook of the late 1880's: '*The Elements of Natural Philosophy*' by Sidney Norton published in 1870.

Matter "…is anything that possesses extension and impenetrability; as earth water and air. The different kinds of matter are called substances which form bodies… Bodies are composed of substances and atoms. An atom is a particle of matter infinitely hard, infinitely small, and possessing a definite size, shape and weight" (p. 7, 20).

Extension - "…is the property by which a certain body occupies space. Extension has three dimensions, length, breadth and thickness. No one can conceive of a body that does not have all these. As a necessary consequence, every body has a certain shape or figure. The figure of solids is permanent. The amount of space that a body occupies is termed its volume of bulk." (p.14)

Weight - "…is due to the forces of gravitation, by virtue of which every particle of matter attracts every other particle towards itself...This definition limits weight to bodies on the earth, but, as the attraction of gravity is universal, a body would possess weight if removed to any of the heavenly bodies."(p.15)

By 1900 a few new terms were added. For example, in the 1906 introduction to '*A First Course in Physics*', by Robert Millikan and Henry Gale, "…*we can measure three fundamentally different kinds of quantities - length, mass and time, and we shall find that all other measurements may be reduced to these three*."(p. 1)

Mass - " The weight of a body is the force with which it attracted by the earth. The mass of a body is the quantity of matter which it contains. The mass of a body is measured by its inertia, or by the force required to give it a certain rate of motion" ('*Elements of Astronomy*' ,Simon Newcomb, 1900, p.84).

Space or Void is the unlimited or incalculably great three-dimensional realm or expanse in which all material objects are located and all events occur. Although these terms were seldom if ever used in descriptive physical science or astronomy books of the 1800's, the issue of the Void, a state of complete emptiness, was a potent issue among early Church theologians. By the 13th century, it was determined that if the existence of the Void were logically impossible, not even God with his infinite powers could create

such a condition. This led to the Condemnation of 1277 by Bishop Etienne Tempier of Paris who struck down dozens of lines of philosophical discourse as contrary to Church doctrines, and an excommunicable offence (Duhem, 1987)

Time – "…is a duration measured either by natural or artificial means. The principal natural indicators of the lapse of duration are the revolution of the earth upon its axis. Time is measured artificially by clocks." ('*High School Astronomy*', Hiram Mattison, 1867, p. 84).

As an element of the Physical World, when we think of the human body, we think in terms of elemental properties. It occupies space and has extension. It has mass, and in the presence of gravity, it also has weight. It exists over a duration of time. It can be seen and is not invisible. In this realm, science is well designed to circumscribe and articulate human physical properties. This invariably leads to a largely negative description of the human form.

Humans consist of physical bodies, which are grosse collections of sensible, matter in atomic and molecular form. They are fragile and subject to wear and tear. They have to be fed other forms of matter, which are then absorbed into the body as foreign material and digested. The human body is therefore tainted by all that it consumes. The human body has a limited sensorium compared to many other animals; a poorer sense of smell than a dog; worse visual acuity than an eagle. Humans cannot even move freely between land, sea and air like some birds. They can survive, naked, in only a narrow temperature range between 50 and 80 F or risk hypothermia and dehydration. No wonder, after thousands of years of being chased by predators and searching for food, and shelter

many humans have decided that there has to be more to what we are than what we are made from.

Before we consider how modern science has revised our understanding of our own physical forms, we must first distinguish among the so-called different realms of human experience. The term 'realm' is one preferred by, for example, the National Academy of Science in their publication *Science and Religion* (Steering Committee on Science and Creationism (1999), namely

"Scientists, like many others, are touched with awe at the order and complexity of nature. Indeed, many scientists are deeply religious. But science and religion occupy two separate realms of human experience. Demanding that they be combined detracts from the glory of each."

Stephen Jay Gould (Gould, 2002) uses the term magisterium to indicate *'a domain where one form of teaching holds the appropriate tools for meaningful discourse and resolution'.*

As an element of these other magesteria, a human can have properties that are entirely non-physical. Spiritual aspects to humans are but one of a myriad of possibilities, and do not exhaust the non-physical attributes which humans have assigned to themselves. This leads to considerable confusion as attempt to bridge the various magneteria or realms of description. For example, a ghost is not a human Spiritual form according to Catholicism, nor do astrological forces affect either the physical or spiritual human forms. The various other influences and 'energies' sited by Asian mysticism and folk medicine also have no obvious relationship to the physical, spiritual or astrological

human forms, and one set of terms is not often allowed to cross into other magisterial. For example, the Catholic Catechism is very firm on this matter,

" All forms of divination are to be rejected: recourse to Satan or demons, conjuring up the dead or other practices falsely supposed to "unveil" the future. Consulting horoscopes, astrology, palm reading, interpretation of omens and lots, the phenomena of clairvoyance, and recourse to mediums all conceal a desire for power over time, history, and, in the last analysis, other human beings, as well as a wish to conciliate hidden powers. They contradict the honor, respect, and loving fear that we owe to God alone (see 'divination' in **CCC, 2011)**.

What all of these magisteria have in common in describing human forms and behavior is that no two of them use the same language or operate by the same rules. So what, if anything, can modern science bring to this discussion about the human form? Most of the other magesteria are static in time. They have adopted specific, traditional languages for describing phenomena in their respective world, in some cases thousands of years old. For most people, this stability confers enormous credibility and respect. This, however, is not the *modis operandi* of science. Science is fundamentally based on the proposition that it is exploring a world in which new ideas must intrude. The acquisition of new ideas is not seen as a liability and a threat to the *statis quo*, but as the central pathway towards developing a more accurate understanding of the elements that fall within its magisterium. Adapting the newer definitions and understandings of the foundational ingredients to the physical world, rather than diminishing the human experience in the other magisteria, may actually allow for a deepening of the theistic experience if that is what one is searching for.

In Catholicism, in the spiritual realm, we have the Holy Trinity: God the Father; Christ the Son; and the Holy Spirit. In science, in the physical realm, we have Matter, Field and Space. First of all, I have to apologize. Matter, Field and Space are ugly terms fashioned for scientific expediency not for their innate poetic appeal, which is obviously lacking. Reducing a delightful drive to visit Grandma for Thanksgiving turkey, to a nuts-and-bolts discourse on engine mechanics and energy conservation, is clearly a bad idea if you are communicating in one magisterium, but in another it is perfectly acceptable. Nevertheless, I envy in many ways the vanished poets and writers who could distill complex theistic thinking into the marvelous poetic short-hand of the Old and New Testaments. Perhaps in time we will decide that scientific knowledge merits the same level of literary care.

Be it as it may, the new language of physical science is firmly rooted in descriptions of Matter, Field and Space. In some ways, these have become the new Aristotelian Elements (Earth, Air, Fire Water). Long ago, when only these four elements had been deduced, it was clear that humans were 'Earth' - a rather corruptible and contemptible element we shared with rocks, pigs and snakes. Hence, the human form, and physical world for that matter, was only seen as a lower form of existence: A rough container for a more perfect spiritual form. With the advent of modern physics, the fundamental elements out of which to fashion a human form are now Matter, Field and Space. Two of these essential elements, Field and Space, are completely incorporeal and invisible, and our footprint in the Matter Realm is actually tenuous at best. After 3000 years, we have created a far more subtle description of the human form. We have also uncovered along the way some rather curious facts about our physical existence!

Exploring the Human, Physical Form

We all have a sense of our own solidity, and that our hands and body are really, and actually, an integrated whole. You are the owner of all of your cells, and each cell is tagged by the essence, genetic or otherwise, of who you believe yourself to be. That means you should be able to count all of the cells in your body and tie them to essential organs and systems that are part of your integrated being.

If we were to count individual cells in your body, 9 out of 10 would be cells within vast colonies of bacteria and viruses. Only one out of 10 cells in your body is technically 'YOU'. While the human body is made up of about 10 trillion human cells, we harbor nearly 100 trillion bacteria. According to Dr. Lita Proctor, the program coordinator of the National Institutes of Health's Human Microbiome Project, which studies the communities of bacteria living on and in us:

"The bacteria cells in our body outnumber human cells 10 to 1", she says, *"but because they are much smaller than human cells, they account for only about 1 to 2 percent of our body mass."*

So, we win in terms of our body mass, but lose in terms of the genetic identity of our component cells. But even among the genetics of the cells we can definitely assign to a process emanating out of our own conception, all is not as numerically simple as we might hope.

We share 96% of our DNA with primates such as chimpanzees (Lovgren, 2005). We share 99.5% of our genome with Homo Neanderthalensis (Green, 2010). About 98% of our 3-billion nucleotides are non-coding 'junk DNA' that in many ways respond to

environmental factors to promote gene expression. Humans have 22,000 coding genes compared to 30,434 in grapes and 16,736 in chickens. (Hesman, 2010). But this simplistic gene-counting is like limiting what you can play on the same 88-key piano to rock and roll, and not considering other musical forms expressed with the same keys, but in different sequences. It is the non-coding DNA that makes this difference. According to McDonald (2011)

"*Our findings are generally consistent with the notion that the morphological and behavioral differences between humans and chimpanzees are predominately due to differences in the regulation of genes rather than to differences in the sequence of the genes themselves*,"

What this means is that the human body is not what it is because of the genes that compose it, but is what it is because of the symphony of gene regulation that is being performed upon its genetic 'keys'. We are, in other words, a the song, not the musical instrument.

We have been speaking about the physical, human form at the cellular level, but what if we go down another few levels to the atomic-scale. We have reduced your intrinsic cellular make up to 10% of all the cells in your body, but 98% of our body mass, so let's congratulate ourselves for not having become completely irrelevant at the cellular sale.

At the atomic level, a level entirely unknown to the framers of the Bible, your body mass, which seems to be dominating the mass of your body, can be reduced to the masses of protons and neutrons. A bit of mathematics would show that for every 50 kg (110 lbs) of body mass, there are about 30 billion billion billion protons and neutrons.

We have lost nothing in this calculation, because when you add up the constituent masses of such a large ensemble of protons and neutrons, you gain back almost exactly the full mass of a human body. Unlike the cellular reduction, there seem to be no new 'aliens' interfering with the arithmetic.

Since the 1960s, physicists have known that protons and neutrons are composed of exactly three smaller particles called quarks. These are the fundamental building blocks of matter in the physical world, so one obtains about 90 billion billion billion quarks for each 50 kg of human body mass. We also know something else about quarks. Although they also contain the intrinsic property of mass, they contain far less of it than protons. In fact, the three quarks that make up a single proton contribute only 1% to the proton's total mass in kilograms. If we now do a bit of math, we see that for every 50 kg of body matter, you only have about 1/2 kilogram of actual mass that you might trace back to the mass of the elementary particles themselves. Where did the other 49 kilograms of missing mass go? To answer this question, we now have to step away from Matter for a few moments and discuss the second fundamental Trinity of our world: Fields.

Magnetic fields are one of the most common fields that the average person knows about by name, although everyone also knows about gravity with the word 'field' not usually mentioned. Pick up two toy magnets and play with them. You will see something that confounded pre-20th century scientists for centuries. What is the nature of the invisible agent that so clearly is able to push around matter? How is it that it has two natures, repulsive and attractive, depending on which magnet poles you try to push together? In the 17th and 18th centuries, it was thought that magnetism was an invisible

corpuscular effluvium emitted by certain bodies. Then in the 19th century, at the hands of physicists Hans Oerstead (1777-1851), Andre Ampere (1775-1836) and Michael Faraday (1791-1867), it was discovered that magnetism could be created by moving charged particles. In lodestone, those particles are actually electrons orbiting within atoms. So, we could understand the origin of magnetism in terms of familiar particles, but what exactly was this 'effluvium' itself? Amazingly, a magnetic field remains unaffected by placing it in a vacuum, so it is not some corpuscular emanation that was interacting with the gases surrounding the magnetic body. It is clearly something that emanates from individual, elementary particles themselves under certain conditions. Fields cannot be divided into elementary fragments like a rock into its constituent atoms and quarks. Fields represent an entirely new feature of the physical world that is inherently invisible no matter what technologies are applied to them. They can only be made 'visible' through their actions upon matter (e.g. iron filings).

Since the mid-1900s, physicists have determined that fields are not a form of matter. They are formed by the collective actions of Virtual Particles. These particles cannot be directly observed by any physical means whatsoever. They are not only invisible, but there is no physical agency we can use to make them visible in transit, and before they have their effect on material particles (electrons, quarks etc). For instance, Virtual photons exchanged between charged particles produce the electrostatic force they feel, and the magnetism that we experience in certain situations.

Physicists have specific mathematical theories, rooted in specific experimental findings, that describe fields, their virtual particles, and all of their possible interactions with matter, with the exception of gravity. There are three elementary fields in nature:

electromagnetic, and the strong and weak nuclear fields. These fields produce forces as a consequence of the exchange of virtual particles that make up the field, which you might think of as a buzzing swarm of bees in mid-air. You may not see an angry bee in transit, but you do experience it when it arrives! The electromagnetic force is mediated by virtual photons. The strong nuclear force, which holds quarks together inside protons and neutrons, is mediated by virtual gluons, and the weak force, which causes quarks to change their identity, are medicated by a triplet of virtual particles called the W+ ,W- and Z0. Once again, although the forces produced by these fields can be accurately measured, the virtual particles themselves cannot be detected by any means. Not only are they invisible, they are not detectable because of specific quantum laws, principally Heisenberg's Uncertainty Principle.

There is only one way in which you can make virtual particles 'visible'. When you provide a virtual particle with enough energy as through the collisions between ordinary matter particles, the fields of the interacting particles store energy, and if the energy is above a particular threshold, the virtual particles that constitute the field can become real, although they may still be invisible. For example, when virtual photons are provided with enough energy they become individual real particles called photons, which though still invisible, we experience as light (electromagnetic radiation) detected at the point of interaction (your retina for example). You can perform this experiment yourself each time you turn on a light. The photons you just created did not pre-exist in the real world, but by giving them enough energy through the electrical circuit, you promoted them into real particles. Even so, they are still completely invisible. Amazing as it seems, you do not observe light in transit. You only observe it at its point of interaction with matter.

You can however detect the changing electric and magnetic fields of an electromagnetic wave in space, which is completely invisible to the human eye. So, you have changed an invisible and un-real particle into an invisible but real particle just by throwing a switch.

For decades, physicists have been performing this conjuring trick of creating 'something out of nothing' by merely providing energy to various fields in space. In fact, it has become such an unremarkable miracle that physicists tend to not even mention it as anything of significance. Each second, physicists in their labs such as CERN in Geneva, create trillions upon trillions of particles in this way: particles that were never included in the original inventory of the instant of creation 14 billion years ago. The reason we can do this is because energy and mass are the same things; a discovery made by Albert Einstein (1879-1955) in 1905, and known to everyone as the cryptic formula $E=mc^2$. The general public may not remember algebra, but virtually everyone knows this formula! This is also, by the way, an example of how pure mathematics leads us to concrete insight about the physical world. Let's see how it works.

Take the Top Quark; postulated to exist in 1973, and discovered in 1995. Now, because mass units are so small we have a new way of referring to 'grams' at the atomic scale. We call them GeV. Don't worry what this means. A single proton has a mass in these units of 1 GeV. The Top Quark is a heavy particle and has an enormous mass of 173 GeV - about as much as 184 protons or a single atom of gold! Pairs of Top and anti-Top quarks were created at the Tevatron accelerator at FermiLab in Illinois, during collisions of protons and anti-protons. Each proton had a mass of 1 GeV. You should note that 2 top quarks have a mass of 346 GeV, but 2 protons have a mass of only 2 GeV. Where did the extra 344 GeV come from? It came from $E=mc^2$, where the protons

were accelerated to an energy which has an equivalent mass of exactly 344 GeV as they traveled close to the speed of light.

Nature is even better at doing this on a grander scale, but it an issue of scale not technique or New Physics. So long as there is a field somewhere, you can pull real material particles out of it without limit so long as you keep supplying enough energy to convert virtual particles into real physical, but invisible, particles. This is not forefront physics that needs to be tested and confirmed. This is the most banal of all physics performed trillions of time every second at accelerators labs around the world every day since the 1940's.

So, getting back to our story about the physical body. Recall that we counted up all the quarks in a 50 kg human, and discovered that only 0.5 kg of this mass could be tracked back to actual mass in a particle: the quarks that make up protons and neutrons. We had missed about 49 kilograms. The reason for this is that quarks are held captive inside protons by the strong nuclear force. This force is generated by virtual gluons being exchanged between the quarks. This field can be thought of as storing the energy equivalent to the missing 49 kilograms! But remember, fields are intrinsically invisible, and are generated by virtual particles which are by definition not physical particles, nor are they even observable in principle. Through a simple consideration of counting mass down to the fundamental scale, we have uncovered a miraculous result. 49 kilograms out of every 50 kilograms of the human body is actually not matter at all, but invisible field energy! This energy is the interaction between virtual particles that are not only thoroughly invisible, but intrinsically not real! We now think we are on the threshold of

understanding another element of the physical world as well. That 0.5 kilograms that seems to remain in our inventory is not really there either!

Pervading all of space, from the quantum depths of terrestrial quarks, to the distant galaxies at the edge of the visible universe, is a new field called the Higgs field. Unlike all other fields in nature, the Higgs field has no source. Instead, we think of it as a 'coloration' to empty space like the red color of a bottle of wine. There is only one other field like it, and astronomers call this field 'Dark Energy'. The Higgs field, instead of causing the universe to expand at an accelerating rate, performs another miracle. It causes all fundamental particles embedded in space to have the property we call mass. Were it not for this field, particles like quarks and electrons would have exactly zero mass, and consequently would travel only at the speed of light. You are welcome to imagine a world in which this were the case!

Were it not for the existence of the Higgs field in which your physical body is embedded, all of your constituent quarks would have zero mass and 100% of your mass would be pure field energy. Astronomers are pretty sure that this condition describes particles in the universe shortly after the Big Bang. In essence, all of the particles that make up our bodies were once second-cousins of pure light energy traveling through space! Now, isn’t this a far more interesting idea for the nature of the human form than corruptible, dirty matter, which our ancient theists so mightily struggled against as they contemplated the physical world? What we now see is that the simplistic idea of a physical world of ‘corruptible’ matter is too confining to accommodate the fundamental nature of the human form. Even at the modern level of understanding, our current physical forms have far more in common with the substance of invisible fields embedded

in space than with anything resembling grosse matter in the Biblical sense! Moreover, since most of our form is the direct result of virtual particles traveling at light-speed, are we not in some sense ‘radiant’ beings?

The fields upon which we are composed have an extension in space, and we have a robust sense that there is a difference between ‘self’ and ‘other’. Surely there is a hard boundary between that which we are as a bundle of fields, and the vast spaces beyond our physical forms? This turns out not to be the case either. The idea of Self and Other is not an a priori fact of our existence. It is made real by specific brain regions that we possess, and probably share with many other life forms on Earth.

There is a specific brain region that controls our sense of boundary in space. Called the Posterior Superior Parietal Lobe (Winkelman, 2010), stroke victims, epileptic seizures in this region, or deep contemplation, lead to an utterly unique and apparently quintessential human experience. You have the distinct sensation that your conscious perspective no longer resides in your body, but that your consciousness has expanded to encompass all of the 'external world'. You feel omnipresent, and Self and Other become experienced as a Unity, and universally felt as a powerful mystical or religious experience. Because this center is also rooted in the limbic system, the experience is intensely emotional. According to

D'Aquili and Newberg (2000),

“*…In this state of Absolute Unitary Being, there are no longer any discrete entities that relate to each other. The boundaries of entities within the world disappear, and the self-other dichotomy is totally obliterated. There is no extension of space or time. If this state is suffused with positive affect, it is interpreted after the fact as the experience of God…*”

Discussions about physical space, which play an important role both in our mental construction of an external world as the facilitator of the Self-Other dichotomy, and in our ability to describe matter and field, require knowledge provided by Einstein's general theory of relativity. This theory, largely crafted in one paper by Albert Einstein in 1915, merits our respect. It successfully predicted the big bang, detailed properties of black holes, gravitational time and space distortion, the fluidity of spacetime in the Lens-Thirring Effect, and the accelerated expansion of the universe. Your hand-held GPS device would not be able to give accurate positions were it not for general relativity being added to the mathematics by which they operate.

The mathematics of this theory are difficult, and well beyond the understanding afforded by a casual contact. There is, however, only one essential message that we need to consider, namely, the gravitational field of the universe is just another name for the older ideas of space and time (more technically called spacetime). In other words, space, time and gravity behave as equivalent concepts. Essentially the force of gravity is not a true force. It is merely a condition in the local geometry of space/time that determines the paths taken by bodies or energy embedded in that geometry. Matter and energy in essence generate space/time and gravity. If you eliminated all matter and forms of free energy in the universe, gravity would vanish and so would space and time. According to Einstein (1920) "*Spacetime does not claim existence on its own but only as a structural quality of the [gravitational] field*".

This revolutionary idea in 20th century physics that is now over 100 years old, will turn out to be the cornerstone to a radically new understanding of the nature of space itself. But in its radical departure from older ideas about gravity, Einstein's view point

sounds a lot like the old philosophical discussion of the Void which emphasized that without bodies, 'place' and therefore vacuum could not exist. If we consider that all bodies produce gravitational fields, we see that Einstein's general relativity arrives at nearly the same Aristotelian conclusion.

The intuitive idea that something must serve as the foundation for space, and spacetime for that matter, is powerfully seductive, and one to which virtually all physicists when caught off-guard, swear allegiance. They do so for the simple reason that to do otherwise leaves their mental constructs of the world literally hanging in mid-air. When we write our matter and field equations that depend on time and space locations, we consider this coordinate grid work to exist in some more fundamental way than the particles, fields and energy they are meant to locate in space and time. We think of these coordinates much the way Newton must have in his world of absolute space and time, describing some immutable, rigid lattice work that is entirely aloof from the less than perfect matter and energy that moves through the grid work subject to nature's physical laws. But Einstein firmly believed that this comfortable, intuitive view was wrong. If the mathematical symbol, $\mathbf{g}_{\mu\nu}$ that we use to describe the geometric aspects to spacetime serves exactly the same mathematical role in the equations as a gravitational field itself, which is what experimental evidence has since shown, then the space and time coordinates we erect to define place and time must also in some sense be constructs of the gravitational field.

Beginning with a landmark paper by Gunnar Nordstrom of Helsingfors in 1913, there have been many attempts to create what are called 'bi-metric' or 'prior-geometry'

theories for gravity and spacetime. Prior-geometry theory sees $\mathbf{g}_{\mu\nu}$ as being actually a compound object in disguise; one part being the gravitational field, the other part representing a pre-existing and immutable arena of spacetime. No observation by the time Einstein proposed general relativity, or since, has ever uncovered any physical evidence for some 'universal geometric object' or plenum which stands aloof from physics in the manner that prior geometry would have to. Prior-geometry theory would also require that some preferred universal frame of rest exist against which, like the ether or Newton's absolute space and time, we could gauge our motion. Also, no phenomenon has ever been discovered which did not obey the principle of reciprocity; the property of acting upon matter and in turn being acted upon by matter. As Sir James Jeans remarked in 1941 about the Ether, perhaps the reason we are having so much time detecting it is because there is nothing to conceal in the first place. The fact of the matter is that the experimental tests of general relativity are even now so restrictive that no other interpretation than Einstein's original one survives, and this validates his assertion that spacetime and gravitational fields are equivalent terms for the same physical object. We should also be mindful of another comment by Einstein recounted by Aylesa Forsee (1963) in *'Albert Einstein: Theoretical Physicist'*, "*...time and space are modes by which we think and not conditions in which we live.*

So, to recapitulate our modern understanding of the human form, most, if not all, of our physical forms are energy stored in elemental fields, which themselves are embedded within the fabric of the cosmic gravitational field. Aspects of this gravitational field are interpreted as 3-dimensional space and time, but these aspects are relative to the observer and are in some sense local constructs. What we have done can be described as

following a road until it became a foot path, that then became a squirrel trail that went up a tree and disappeared into a knothole. One type of 'essential physical reality' transitioned smoothly into another, until we finally arrived at the foundational idea expressed by three physicists:

"*The essential reality is given by a set of fields, and the quantum dynamics of those fields*" Steven Weinberg (1982) - Translation: At its most elementary level, the physical world can be logically, and experimentally, reduced to the behavior of fields embedded in space, and the ways in which those fields interact to give the sense mass and force.

"*The material particle has no place as a fundamental concept in field theory. Gravity as a field theory must also deny a preferred status to matter*" Einstein(1950) - Translation: Gravity is a field, not unlike the ones that provide the experience of mass and force, so there must be an intimate, even existential, relationship between gravity, space, time, and matter, with all ingredients co-equal.

'What else is there out of which to build a particle except spacetime itself?" John Wheeler (1964) - Translation: Because there is no experimental or logical proof that gravity and spacetime are imbedded in a larger plenum, spacetime must be the end-of-the-road for creating matter and field in the physical world.

The origin of our spacetime, that ineffable field that serves as both the container and the foundation of the fields that make us up, was a titanic event we know as the Big Bang. Living on 'this side' of the Big Bang, we have no recourse but to do the best we can to create a coherent logical picture of our universe and its evolution over the course of 14

billion years. If Nature were not based upon regularities spanning vast expanses of space and time, we would doubtless not be here. Although we may argue about what dependencies spiritual 'matter' might have on the physical world, at least our physical forms depend on basic building blocks assembled through evolution over eons of time. This leads us to appreciate the intimate relationship between Nature's Laws and our very existence, whether we have souls or not. Nature's laws seem to be written in some way in the very fabric of space itself, in the same way that our own bodily fields are. There is no other place for them to be writ. Only things embedded within spacetime itself can be causally connected to the various outcomes of events within spacetime. And so, the descriptions that physicists offer about 'what comes next' lead very quickly to an impass of sorts.

The relentless, and highly successful application, of mathematics and logic in our description of the physical world and the many invisible 'consorts' that exist in parallel with it, beg the ultimate question:. What do we make of mathematical descriptions that transcend our ability to test them in the standard way that science must do?

In some historical situations, this transcendence has been good, and has led us to an expanded and more accurate (at least computationally) view of Nature. For example, in the 1940s it became a necessity to add virtual particles to our physical model of how electromagnetism operated. They are the cornerstone of modern quantum field theory, but they can never be directly seen. Their existence can only be confirmed through their collateral interaction with matter. Even Heinreich Hertz mused about this tendency. In his book 'The Principles of Mechanics Presented in a New Form (Hertz, 1894) he noted that ".. *If we wish to obtain an image of the universe which shall be well-rounded, complete*

and comformable to law, we have to presuppose behind the tings we see, other invisible things. We have to imagine confederates concealed beyond the limits of our senses".

Today, many new theories of the foundations of the physical world have sprung up, each with their own international communities of researchers. You may have heard about their cosmological consequences in terms such as supersymmetry, multiverse, 11-dimensional spacetime and the Anthropic Principle. These are ideas, elegantly stated in the mathematics, beautiful in their logical exposition, and exciting to contemplate in a universe that has grown curiously cramped. All of these ideas confront science with new challenges. With supersymmetry, we can account for the physics that we observe in terms of a larger arena of increasingly more exotic and massive particles beyond our technological abilities to create and study. We can extend our quantum mathematics of statistical ensembles to include our universe as one among a multitude, each with its own physical laws, but utterly separated from our own. We can increase the dimensionality of space, and find our own laws as one among many possibilities, but we cannot marshal the technology to probe these other possibilities directly. Finally, we can mathematically attempt to create only one unique, logically consistent universe consistent with all that we know and can measure, or we can posit an infinitude of universes but through the Anthropic Principle, find only a small number consistent with our physical life. In essence, our very existence is a crucial datum that tautologically bends the mathematical possibilities to conform exactly to our unique world.

Just as for virtual particles, we may find that these ideas facilitate better understanding, but necessarily add elements which are not directly measurable. It was minor detail of concern to theoretical physicists when these 'invisible confederates' were

merely virtual particles. But now we speak in terms of entire 'invisible' universes complete with alien laws that have to temporarily enter our calculations in order to avoid creating ‘infinities’. Who among us cannot muster a sense of awe at the audacity of modern theoretical physics. In the search for grand unification, logical coherence, and a higher level of beauty, we now embed the cosmos in the vast sea of the eternally invisible multiverse just to make predictions in our own physical reality lead to rational, and testable, answers.

It is a feature of general relativistic cosmology, and the intimate relationship between space, time and gravity, that at the Big Bang, space and time vanished. Some call this condition The Singularity because familiar quantities of energy, temperature and gravitational strength become infinite, although many physicists are convinced that some 'quantum' description for gravity will be required to accurately describe this state. Stephen Hawking prefers a model in which the original cosmic state was one of pure 4-dimensional space. The Big Bang occurred when, through a process called quantum tunneling, one of the space dimensions became time-like and time was born 'explosively'. A state of pure-space does not exist in time, so the concept of a beginning is meaningless. Other ideas propose a vast spacetime plenum within which 'bubbles' form and break off from existing universes to become their own separate universes. The breaking-off event is seen as a Big Bang from the standpoint of an inhabitant inside a bubble universe.

These amazing mathematical theories raise more questions, not the least of which is whether it will ever be meaningful, scientifically or in any other fashion, to discuss what happened 'before' the Big Bang event…or whether such questions have any inherent meaning. After all, humans are capable of asking any question imaginable including 'how

many angles can dance on the head of a pin?". Every question that we can invent can sound logical and worthy of an answer, but we have always appealed to something we refer to as the Real World to narrow our choices. But what happens when we can no longer appeal to aspects of known Nature to guide our questions?

The mathematical questions now being launched by modern physics have only logical consistency, and a bare smattering of heavily-worn data within our spacetime, to serve as a guide. There are no obvious ways to test whether a multiverse exists or what the nature of its inhabitants and geometric structure might be. In the end, we have a working example of only one universe, and by all extrapolations, only one vanishingly small patch of the spacetime that emerged from our Big Bang.

Even worse, the kinds of experiments that would guide us in creating a better relativity or quantum theory are now beginning to outstrip our financial resources as a world society for this kind of activity. The CERN Large Hadron Collider was built at a cost of $9 billion. If it should turn up no new fundamental physics such as the Higgs particle or supersymmetry, how easy will it be to get funding for an even larger accelerator?

In consideration of the nature of human beings, it is widely accepted that we owe the very existence of our physical form to the pre-existence of specific laws of nature, and populations of fields and particles moving about in spacetime. This leads to several inevitable conclusions. The preponderance of our physical matter, if not its entirety, is actually energy stored in fundamental physical fields, which in turn are virtual particles. The 1% of our substance that is measurable matter, when interacting with the other forces (themselves invisible) is responsible for all of the attributes we observe as our physical

forms. These attributes are easily measurable with conventional and unremarkable means. The fact that 99% of what we are is a medium that consists of particles that are not only invisible and technically not real, but not even detectable even in principle, is an interesting realization.

When theists think of the human Spirit, they think of something of indeterminate substance but at the same time quite ineffable, that defies any scientific means for detecting or measuring. Matter is substantial and measurable. Fields are not substantial but are measurable. Virtual particles are not substantial but are also not measurable. Rather than thinking of the physical world, and our corporeality, as substantive and corruptible, it is far better to recognize that our world is dominated by incorporeal fields in space, with matter a 'trace impurity'. This leads to my own personal revelation about what I am.

" In my minds eye, I see a vast landscape of fields busily curving spacetime and steering the motions of matter. Beneath this, I see ghostlike things that scurry around knitting the Void together, suspending it like a spiders web above the great abyss of nothingness. I feel the hardness of my body and the ground beneath my feet dissolve away into the invisible gyrations of spacetime curvature, in a seamless way reuniting my body with the Void itself. My substance is taken up by the energy of hidden fields, themselves dissolving into the comings and goings of web works at the foundation of space and time itself. Within the mysterium of physical science, the human body has truly been replaced by a song, played upon the keys of invisible fields. ". (Odenwald, 2002).

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