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Article

The Physics of Augustine: The Matter of Time, Change and an Unchanging God

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Abstract: Scientific questions posed by St. Augustine, early father of the Christian church, are presented as a part of a proposed undergraduate course for religion and philosophy students. Augustine regularly seasons his religious, philosophical and moral investigations with analysis focused on the physical nature of the universe and how it can be quantified: "And yet, O Lord, we do perceive intervals of time, and we compare them with each other, and we say that some are longer and others are shorter" (*Confessions*, Book 11). The physical analysis is sometimes extended, pressing the attention and grasp of the unsuspecting student of religion or philosophy. Though Augustine emphasizes that true knowledge comes from faith and revelation, his physical inquiries imply that he values such analysis as a way toward truth. In contrast, Master of Divinity programs, which train the majority of Western Christian ministers, require little science experience and usually no physics. Serious investigation of Augustine's physical explorations reveal an alternative way of understanding scripture, especially Jesus' sayings: could the master engineer who created the universe sometimes be speaking in straightforward scientific terms?

Keywords: Augustine; pedagogy; core texts/great books programs; history of Christianity; physics; time; science and religion

1. Introduction to Augustine, the Physicist

> What, then, is time? If no one asks me, I know what it is. If I wish to explain it to him who asks me, I do not know…

> But, then, how is it that there are the two times, past and future, when even the past is now no longer and the future is now not yet? But if the present were always present, and did not pass into past time, it obviously would not be time but eternity…
>
> …And yet, O Lord, we do perceive intervals of time, and we compare them with each other, and we say that some are longer and others are shorter. We even measure how much longer or shorter this time may be than that time…But we measure the passage of time when we measure the intervals of perception… (Augustine, *Confessions* 11:XIV–XVI).

St. Augustine is recognized as one of the most important early church fathers. He is said to be an expert in rhetoric (though he later despised this vocation), persuasive writing, theology and philosophy. However, an experienced physicist, reading Augustine's most well-known book, *Confessions*, is startled by his sudden shift from descriptions of personal failings and his relationship with his father and mother, to a physicist's discussion of the nature of time, how it is measured and time's relation to past, present, future and "eternity". He proceeds to question how a "changeless" God could possibly *do* anything, if time can only be defined in terms of change. The unsuspecting physicist, coming upon the above passage as an isolated quote, would, if "O Lord" were removed, assume a quote from a fellow physicist, perhaps writing for a popular audience. While a philosopher might also be proposed as the source, the impulse to *measure* and compare the magnitude of one interval with another is a primary feature of physics, the most fundamental quantitative science. Of course, the scientific method did not exist till long after Augustine's death. Though Archimedes, Eratosthenes, Hero, Ptolemy and others before Augustine may be called physicists, Physics, as a formal discipline, began in the tenth century AD and later. Nevertheless, Augustine's apparent tendency to think in terms of physical quantities and their measurement should qualify him as at least an honorary physicist.

Augustine's scientific capabilities and fixation on time, eternity, creation and the nature of God and His relation to man, is further amplified in his other writings, and suggests that he often thinks *as a true early physicist*. At the same time, Augustine is suspicious of natural reason, emphasizing that the source of true knowledge is faith:

> But since the mind itself, though naturally capable of reason and intelligence is disabled by besotting and inveterate vices not merely from delighting and abiding in, but even from tolerating His unchangeable light, until it has been gradually healed, and renewed, and made capable of such felicity, it had, in the first place, to be impregnated with faith, and so purified...Now the only way that is infallibly secured against all mistakes, is when the very same person is at once God and man, God our end, man our way [1].

Augustine's attitude toward his own scientific explorations seems to be one of simultaneous wariness and expectation of revelations, after renewal of his (scientific) reason through faith.

This paper focuses on a few scientific questions raised by Augustine, related to time: how a simple, but hard to grasp, physical model of time(s) offers simple, but hard to grasp, answers to some of Augustine's questions. The approach is physical, designed as part of an undergraduate physics course for students of religion, philosophy, divinity, and physics, with an insistence that,

(i) arguments must be quantified,

(ii) that models and theories must be tested, both with experimental evidence from the natural world *and* from the Bible and

(iii) that scripture be interpreted, at least initially, in its most straightforward, physical, literal sense.

The biggest challenge seems to be conveying an understanding of the dimensions—spatial and temporal—of our normal universe, how the laws of physics require smooth connections between one, and a subsequent, instant of time, and how reality is affected if an additional space or time dimension is added. St. Augustine's contemplations of time and space can be viewed as an early attempt to formulate these quantitative laws, explicitly demanding that Biblical descriptions ("faith") of an unchanging and all-powerful God[1] simultaneously fit with these formulations. In a sense, Augustine was an early theologian and scientist who believed that religion and science do not occupy separate spheres of understanding, but should fit smoothly together.

By necessity, a physics course designed for undergraduate religion or philosophy majors must be introductory. Like all standard introductory physics courses, it cannot be technically correct when it deals with "real life"; to do so would overwhelm the new student. While complicated and cutting-edge information is often transferred to students in other disciplines, physics focuses on a student's ability to use fundamental, quantitative principles to generate his or her own answers. Examples of technically incorrect treatments of physical phenomena in physics courses abound. The treatment of projectile trajectories, assuming only the force of gravity were relevant, would have gotten a 17th-century artillery advisor imprisoned for incompetence, yet this is how we still teach undergraduate physics. This is justifiable because (i) to include the other relevant forces would overwhelm the new student; and (ii) the simple treatment points the student in the right direction for understanding. The ideas presented in this paper ignore relevant advanced physics topics, such as general relativity and cosmology theory, in favor of a simpler approach that allows students, on their own, to both *calculate important quantities* related to some biblical statements, and to interpret scripture from a physics point of view. A second, more advanced course on physics and theology might include important topics such as cosmology, quantum gravity and general relativity [2], but the treatment would still need to be at a "factual" level. Such advanced physics material is usually only mastered by physics graduate students specializing in theoretical or mathematical physics. The reader can make a useful connection between the current paper and these more advanced treatments by examining the chapter in the just-cited reference entitled "The Debate Over the Block Universe". (This paper falls mostly on the "block-universe" side of the debate.)

Why does the issue of time play a central role in Augustine's physics? The laws of physics, as currently understood, all relate fundamental measures of mass, position, activity, and capability to the passage of time. For example, Conservation of Energy, asserts that the total amount of energy in a defined, isolated system remains constant with time. This would initially seem to correlate with the biblical idea that God is unchanging:

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[1] Use of the descriptor "all-powerful" will be briefly explored in this paper. The author does not believe that Augustine explicitly asserts that God is "all-powerful" in the commonly (mis)understood sense of "He can do anything we can imagine".

> Every good gift and every perfect gift is from above, coming down from the Father of lights with whom there is no variation or shadow due to change. (James 1:17, English Standard Version).
>
> "For I the Lord do not change; therefore you, O children of Jacob, are not consumed." (Mal. 3:6, ESV).

Augustine seems to have noted the difficulty that a truly *unchanging* God could *do* nothing, since *doing* is defined by change with time:*…time does not exist without motion or change…*Religious or philosophical treatments of these passages usually resort to interpretations of "change", "changeless" and time in specialized senses: "changeless" refers to some inherent nature or properties of God, such as His goodness or holiness, but not to inactivity.

In physics, the connection between *action* and *change* is clear. Forces cause a change in motion, as in Newton's Second Law of motion:

$$F = ma = m\frac{\Delta v}{\Delta t} = m\frac{\Delta\left(\frac{\Delta x}{\Delta t}\right)}{\Delta t} \quad (1)$$

where F, m, a, v, *x*, and *t* stand for force, mass, acceleration, velocity, position and time. We interpret force as the cause of changes in motion or in stored energy. The multiple occurrence of the symbol Δ, representing "change in", shows that the principle of change is deeply embedded in the laws of physics. Even the principle of conservation of energy—that total energy of an isolated system does not change—contains implicit time dependence, since kinetic (motional) energy is defined in terms of a velocity, $v = \frac{\Delta x}{\Delta t}$, and since various forms of energy making up the constant total can interconvert as time proceeds. While some might argue that God's unchanging nature may be the equivalent of total energy, with a myriad of changes and conversions going on beneath the surface, Augustine's writings on time show that he considers our time to be inapplicable or irrelevant to God's nature and action.

One can propose to focus a program of study solely on the nature of time and of God's unchanging character. The track of such a study typically leads to philosophical explorations of the definition(s) of time and their evolution over history. We propose a different track: to start with the known laws of physics, view them in terms of the mathematically-required continuity and smoothness of trajectories as time proceeds, with no explicit "definition" of our dimension of time outside of this requirement that the arrangement of objects at one instant of time must fit smoothly with arrangements at previous and subsequent instants. If God is to fit into this model, but remain unchanging but active, the simplest way is to propose a second dimension of time; not a second "type" or "meaning" of time, but a second dimension. The test of such a model involves checks on (i) whether and how an existence can make any sense with two time (or time-like) coordinates; (ii) agreement with known laws of physics in our normal world; and (iii) agreement with descriptions in the Bible. All three of these requirements work toward eliminating the freedom to redefine and adjust meanings to better conform reality to one's personal notions. In short, we seek to maintain a scientific approach. The ultimate objectives of this effort are to develop a flexible (expandable) course or course module that could either be taught as a standalone course or as a "module" in a core course in natural science, physics, religion or philosophy

at the junior/senior undergraduate or graduate (masters) level. Such a course or course module might be called "Physical Theology".

2. The Student

The number of 21st-century people who are interested in, and might need to better understand the connections between, the physical laws of the universe and theological ideas of a supreme being is presumably large, at least in comparison to the number of physicists in the world. A new course that aims to be of value to that large number of people can approach this educational goal in one of two ways: (i) prepare a course or educational materials for this large group or (ii) educate the natural teachers of this large group—the ministers who serve local religious congregations. Approach (i) suffers from the tendency to produce a work (e.g., a book) that will attract popular attention and can be digested in a relatively short amount of time. This is difficult in the case of physics, because physics insists on understanding specific questions and observations from fundamental principles—an arduous process—and because these principles do not seem terribly spectacular. For example, to understand how an iron axe-head might float[2], a physicist would need to start from elementary principles of force (Newton's Laws) and buoyancy, using calculations to back up assertions. This would take a large amount of time for the meager goal of understanding one recorded statement in the Bible. Approach (ii), which aims to train those ministers who will teach much larger audiences on a weekly basis, seems more hopeful. These ministers would rarely teach physics *per se*, but would incorporate a mindset of the boundaries of physical laws into their messages.

The majority of future ministers in the Christian western world train in Master of Divinity (M.Div.) programs. Most such programs are professional, with specified student courses and experience required for accreditation. A recent (2011) survey by the author and Philip Markham, then a M.Div. student at the Beeson Divinity School of Samford University, on the physical science background of M. Div. students in schools accredited by the Association of Theological Schools (ATS), revealed virtually no physical science expected of M.Div. students. See Figure 1. (More details can be found online [3])at Of the one hundred seventy survey invitations sent to deans, associate deans or directors of academic programs of ATS-accredited schools, 45 responses were obtained—a response rate of 26%). When asked the percentage of students who study physical science while enrolled in their M.Div. program, 54% of program directors responded, 0% of students; 40% responded, 1%–10% of their students. Two directors stated that more than 20% of their students study physical science while enrolled.

When asked to rank the importance of new course material in their program, additional physical science course work ranked sixth (last), behind international cultures, psychology, music, management/business, and law. Considering the professional status of M.Div. schools, it is perhaps understandable that training their students to manage a church, with its expected daily tasks and problems, comes out ahead of a gaining a better ability to (scientifically) comprehend the physical laws of existence and the relation to heaven. One conclusion from this information is that an attempt to insert a significant amount of additional physical science into a professional M.Div. program will

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[2] So the man of God said, "Where did it fall?" And he showed him the place. So he cut off a stick, and threw it in there; and he made the iron float. II Kings 6:6 (New King James Version).

likely fail. A comment from one survey respondent, that their program expects incoming students to have the needed science background from their undergraduate degree program, suggest that an attempt to insert a "Physical Theology" course into an undergraduate religion or philosophy curriculum might be more successful.

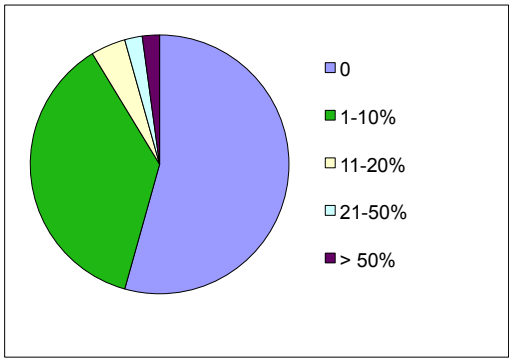

Figure 1. Percentage of students who study physical science while enrolled in one of 45 M. Div. programs.

M.Div. students have a variety of undergraduate backgrounds, but commonly graduate from B.A. degree programs in religion and/or philosophy. Proposing a standalone Physical Theology course that fulfills a core science requirement is not a viable option in many universities, but a full course or course module on this subject might well fit into upper-level electives in religion and philosophy programs. Such a course module might also be considered in interdisciplinary or liberal-arts majors in the sciences.

3. What Is Time and How Does It Govern Physical Laws?

We cannot and will not attempt to answer the question "What is time?" other than to indicate that the precise nature of time is not well understood. Augustine argues that the "time" we humans have some intuitive feeling for came into existence with the creation of the universe [1]. This would seem to make sense, since the primary (perhaps only) use of time in physics theory relates changes and movements of matter and energy to a time variable. There would, then, be no time if there were no matter/energy. In the model presented in this paper, this understanding would remain, with the revision that our normal time forms the linkages between instants of existence. One has only to look at the proliferation of recent books and review articles about time and whether it exists at all to know that this topic is still actively discussed, at least in the popular, scientific press [4–11]. In fact, the primary laws of physics have been applied for hundreds of years without knowing the precise physical nature of time at all, beyond its occurrence as a fundamental independent mathematical variable, upon which many physical quantities depend. The author, like typical practicing physicists, was never bothered about the question, "What is time?", in spite of nine years of formal university education in physics and decades of experience with precise measurement of time from 1 picosecond (10^{-12} s) to hours or more. The one exception to "never bothered" occurred in an advanced quantum mechanics course, in which the state of an elementary particle at a time, t, required the inclusion of interactions at other times, both before *and after t*. Causality thus became an issue of discussion for a short time.

Nevertheless, physicists and non-physicists alike constantly rely on measurement of time and of quantities that depend upon time: age, position, velocity, force, energy, chemical reactions, biological metabolism…If we could not use measures of time in a practical way, the world would make no sense.

We are, in fact, more and more dependent upon increasingly precise measurements of time, an aspect of life that Augustine commented on (See previous quotes). The world standard measure of time is partly maintained by the National Institute of Standards and Technology (NIST) in the United States, consists of a cesium fountain atomic clock, and is one of an international group of atomic clocks that define Coordinated Universal Time (UTC), the official world time. The uncertainty of this atomic clock, as of January 2013, was about 3×10^{-16} second: this clock would neither gain nor lose a second in more than 100 million years. This precision may seem a bit extreme, but some aspects of our lives, such as GPS systems, depend on precise time measurement. Unlike our understanding of atoms, protons, neutrons, and other particles, where fundamental theories and experiments have predicted and confirmed substructure in these particles, we have no theory of time that proposes that it might consist of more fundamental entities.[3]

3.1. The Nature of Time

A clear distinction should be made between how the physicist employs measurements of time to understand and predict phenomena, using laws of physics, and human, intuitive perception of time. Except to point out the most common view, we leave the latter field to students of psychology.

3.1.1. The Math

The physicist writes that the position, *x*, of a car, starting from position x_0, moving with an initial speed, v_0 (speed at some initial *time*, defined specifically for the phenomenon at hand to be time = 0), and a constant (independent of *time*) acceleration, a, depends upon *time* in the following mathematical way:

$$x = x_0 + v_0 t + \frac{1}{2} a t^2 \tag{2}$$

Actually, this equation does not represent any fundamental principle; rather, it results from the fundamental principles and physical definitions:

$$\begin{aligned} \mathbf{a} &\equiv \Delta_t \mathbf{v} \\ \mathbf{v} &\equiv \Delta_t \mathbf{x} \end{aligned} \tag{3}$$

where Δ_t represents a mathematical time derivative of the quantity that follows it. Most of us learned the simple version of the second equation in (3) in grade or high school as "distance = rate × time", where "rate" is "**v**". Underlying all these relationships are basic laws:

$$\begin{aligned} &\text{Newton's Second Law: } \mathbf{F} = m\mathbf{a} \\ &\text{Conservation of Energy: } E_{final} = E_{initial} \end{aligned} \tag{4}$$

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[3] This also applies to the *x*, *y* and *z* coordinates of space, though we know time is a different sort of entity.

where F = force, m = mass, a = acceleration, and E = total energy. We will not belabor any mathematical points. The primary take-home message for scientists and non-scientists alike is that we do not have to specify the precise nature of time in order to employ the great laws of physics to understand or predict most of the universe's behavior, from atoms, to galaxies, to iPhones. We physicists only need to know that position, velocity, energy and other physical quantities depend "smoothly" on a measure called "time", which seems to always increase in the positive direction.

3.1.2. The Perception of Time

The term "river of time", or some expression reflecting the notion that time flows in the forward direction, is often used to convey how the world behaves as time goes by. When asked in a scientific context, we 21st-century citizens usually go a bit further and claim that time flows constantly, inexorably in a forward direction, and that this flow pays no attention to what happens to be going on in our world or in his or her life. Even the expressions, *as time goes by*, or *as time passes*, reflect the intuitive idea that some mysterious quantity we refer to as time, is somehow moving. However, when asked simple, standard questions, like "Moving in what?" or "Moving with respect to what?", we are confounded, moving from statements like, "Well, it depends on what you mean…" to, "Why does it really matter?", to "Oh, just shut up!". The more thoughtful would perhaps reply,

> What… is time? If no one asks me, I know what it is. If I wish to explain it to him who asks me, I do not know. (Augustine, *op. cit.*)

One thing is perfectly clear: as long as we leave time—an independent quantity, essential to all physical laws, laws that describe our universe in as much detail as we normally ask; whose extent can be measured as precisely as we might desire; whose passage is tied to virtually all important, human experience (like our jobs and our lifespan)—as a murky and unspecific, but unique and fundamental, quantity that individuals are free to interpret as they prefer, and that physicists have no need to interpret, we will not make much progress on Augustine's most fundamental questions:

> But how didst Thou make the heaven and the earth? and what is the engine of Thy so mighty fabric? …
>
> [they] strive to comprehend things eternal, whilst their heart fluttereth between the motions of things past and to come, and is still unstable. Who shall hold it, and fix it, that it be settled awhile, and awhile catch the glory of that ever fixed Eternity, and compare it with the times which are never fixed, and see that it cannot be compared; and that a long time cannot become long, but out of many motions passing …but that in the Eternal nothing passeth, but the whole is present… [12].
>
> …time does not exist without motion or change…[13].

We could redefine the meaning of words like "unchanging" to refer to only a restricted set of characteristics, like "character" or "knowledge", when describing the Christian God. We may also be

unable to resist the invention of new words, like *supralapsarianism*, *eisegesis*, *a- and b-series of time*,[4] with the claim that we cannot expect usual human words to correctly describe God or the entirety of our reality. (See, for example, dictionaries of philosophy or religion, [14,15]) Physicists, Augustine included, would respond with, "Words are fine, but tell me how to calculate something that I can compare with reality."

3.1.3. A "Fearful" Proposition about Time

> The fear of the Lord is the beginning of wisdom. (Proverbs 9:10).

While refined philosophical/religious definitions and words can be explained and justified, they seem to have little connection to the "fear of the Lord" that is said to be the beginning of wisdom. Such wisdom would seem to be a fundamental goal of religious philosophers. Augustine seemed quite fearful of the Lord, and wrote of it in connection with his questions related to "What is time?" This author is not thoroughly read in Augustine, but it seems that Augustine is not very concerned with applied physics issues like "What determines the range of a projectile?" or "How can we store energy for use later?"—questions that were favorites of physicists of the 17th century and later. His main concerns relate to the operation of the universe and God's relation to it. The intensity of his desire to understand emerge soon after declaring his questions about how time works:

> My soul is on fire to know this most intricate enigma. Shut it not up, O Lord my God, good Father;…This is my hope, for this do I live, that I may contemplate the delights of the Lord.
>
> Behold, Thou hast made my days old, and they pass away, and how, I know not. And we talk of time, and time, and times, and times…(Augustine *Confessions*, *op. cit.*).

Augustine thought about many deep, unsettled, and unsettling moral issues, but when he wrote of his soul being *on fire*, he had just described his attempts to understand the enigma of time and how God and the universe fit together. How can we comprehend this fire in his soul? We could minimize the scope of his blazing concern by supposing Augustine was worried about his own eternal destiny. However, his use of the words "hope", "live", and "delights" suggest that his soul-fire was more akin to the feelings of Christian and Hopeful, in *Pilgrim's Progress*, as they approached their goal:

> …drawing near to the city, they had yet a more perfect view thereof…by reason of the natural glory of the city, and the reflection of the sunbeams upon it, Christian with desire fell sick; Hopeful also had a fit or two of the same disease…[16].

What ideas about time might instill a deep sense of "fire", "fear" and "delight" in Augustine? Perhaps he had some inkling that the fundamental question of how God and our physical universe fit together focuses on the single question: "What is time?" A Physical Theology course would fail its main purpose utterly, if it did not address the fundamental physical principles that underlie the relationship between God and His creation, without resorting to a simple segregation of the "earthly" from the "heavenly". After all, God did not segregate himself from our world. Physical Theology, in

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[4] This last pair of philosophical definitions, pointed out to the author in 2007 by Rev. Dr. Rodney Holder, former Course Director of the Faraday Institute of the University of Cambridge, led, by a circuitous route to the simpler, more "physical" view of times discussed in this paper and the proposed Physical Theology course.

the tradition of Saint Augustine, can and should freely admit its shortcomings and questions, but it cannot simply assert that the physical world obeys laws of physics and the theological world, the laws of theology (or religion or philosophy). A clear biblical reason for a required intimate connection between physics and theology can be found in the Bible:

> In the beginning was the Word, and the Word was with God, and the Word was God. He was with God in the beginning. Through him all things were made; without him nothing was made that has been made. (John 1:1–3, NIV).

The meaning of the "Word" is described later in this passage as being the person of Jesus, the Son of God and one "member" of the trinity: God, the Father, Son and Holy Spirit. Jesus is later described as being born as a human being, but still being God, the Son. Physical Theology should seek to understand these rather simple[5] statements with a simple, enlightening, non-obfuscatory model that integrates Jesus' material qualities with His eternity and ability to create all things. How can we possibly accomplish this integration, and how might this involve Augustine's questions about time?

To introduce a possible model of time, to be evaluated by students of Physical Theology, we appropriate in Figure 2 a graphic created by NASA:

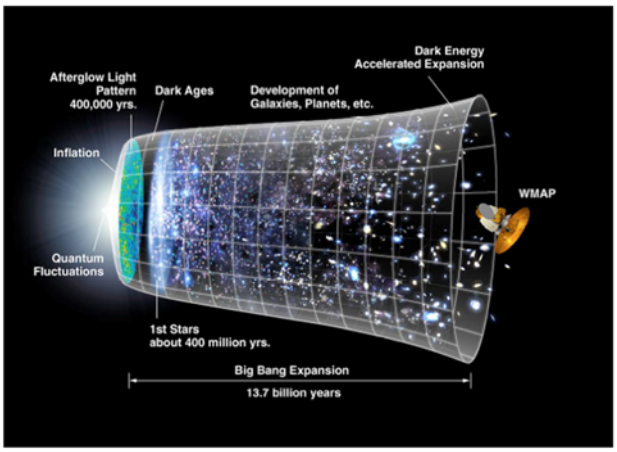

Figure 2. "Time Line of the Universe" The time-dependent structure of the universe in four dimensions—three spatial (x,y,z) and one time (t)—is expressed in a pseudo-3D image by ignoring one spatial dimension and replacing the horizontal spatial coordinate by the time coordinate. Graphic courtesy of NASA: may be freely used for educational and informational purposes [17].

Such a picture of the development of the physical universe was earlier used by Brian Greene, in his 2004 book *The Fabric of the Cosmos*, and was described as a "view from nowhere" [18]. The implication of Greene's statement was that this Figure 2 view of physical reality did not reflect what any human or imaging device could "see" from any point in the universe. The author (TN) has used the simplified picture shown in Figure 3 in several special university courses since 2003 to illustrate the ideas that (i) our real universe can be viewed in terms of time "slices" of the 3D structure of the universe; and (ii) that the laws of physics can be viewed pictorially as requiring a smooth, continuous path of an object. In Figure 3a, an object's path can be tracked with no abrupt changes in direction and

[5] "Simple", in the sense of uncomplicated, not necessarily "easy to understand".

no discontinuities in the track. In Figure 3b, the object's track changes direction suddenly, corresponding to the application of a large force. This track may be consistent with laws of physics (e.g., Equations (1)–(4)), but if the discontinuity is abrupt enough, the force may correspond to a concentration of power large enough to create matter-antimatter pairs, which could then create a large explosion. Such matter-antimatter creation has been done with high-power, pulsed lasers [19,20]. Figure 3c shows an object following a discontinuous track. Such discontinuity implies the application of an infinite force and power, which violates the laws of physics and could, if the displacement were just "almost" instantaneous, create conditions required for the generation of a "bubble universe" [21]. Such events may not be welcome to any human that happened to be near.

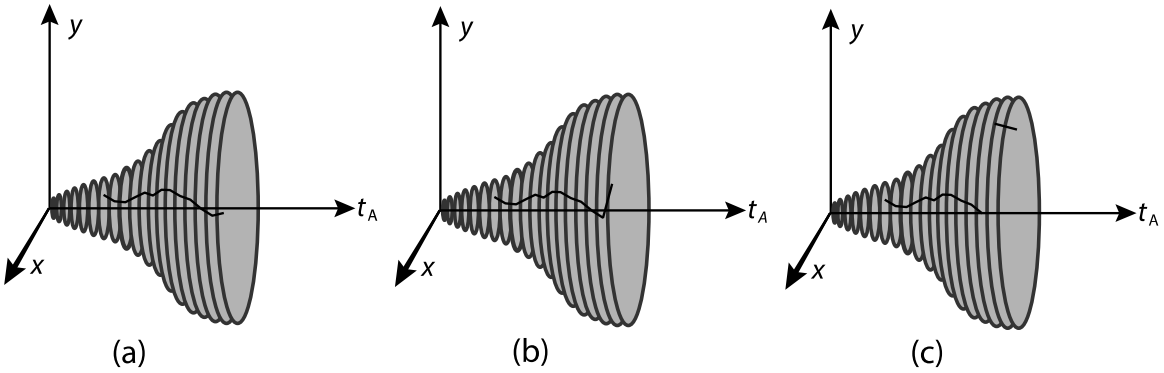

Figure 3. Two of the three spatial dimensions (*x*, *y*), with the one normal time dimension plotted horizontally in place of the z dimension. The entire spatial structure of the universe at a given time along the t_A axis is represented by the corresponding time "slice". (**a**) the path of a normal object, obeying the laws of physics, follows a smooth, continuous path as time increases. (**b**) an object subject to a sudden, very large force. (**c**) an object violating the laws of physics.

Though some of the mathematics of path continuity in Figures 2 and 3 should be presented in a physical theology course, this pictorial representation of laws of physics gives the less mathematically-inclined student a visual handle on the main issue, that laws of physics prevent disruptions and discontinuities in physical processes, and that extreme discontinuities (miracles?) can be accompanied by extreme, and perhaps destructive, energetic events.

A quick response of some religious readers to Figures 2 and 3 might be that this is "God's view" of a reality, which includes more than just what we humans can see. There are, however, several problems that this interpretation. First, Figure 2 has introduced an additional dimension, beyond our normal four dimensions, without any description of its properties and evidence for its existence. Second, the introduction of additional dimensions to existence must satisfy constraints of predictability and stability, described by Max Tegmark (Figure 4) [22]. In a Physical Theology course, this issue would be investigated at a simple level. One of the possible conclusions resulting from Figure 4 is that our normal, human existence can *only* explore three spatial and one time dimension. If the universe has 7–8 more spatial dimensions, as in string theory, those extra dimensions must be tiny and "curled-up", preventing humans from personally exploring them. The next course exploration would be to consider

whether an additional time (or time-like) dimension could exist. In spite of dozens of time-travel novels and movies, such a possibility would incur the "unpredictable" stamp of Figure 4.

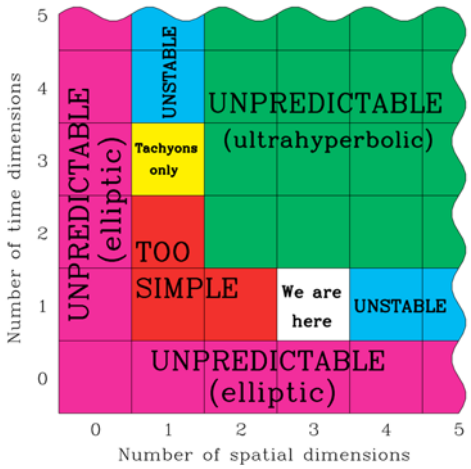

Figure 4. Graphic "On the dimensionality of spacetime", by Max Tegmark (No implied endorsement of the present work) [23]. Licensed under the Creative Commons Attribution-Share Alike 3.0 Unported license.

"Unpredictable" does not just mean that we may get some surprises along the way; rather, nothing would make sense and normal materials would not hold together. Cause and effect would take a holiday, depending upon exactly what rules might govern processes involving both time dimensions. Taking a breath might not result in air entering one's lungs. Our bodies that are constructed of flexible, constantly-moving chemical and mechanical parts could not sustain their stable life.

Going back to the possibility of Figures 2 and 3 being "God's view", the next question to be investigated might be whether a being like God could navigate in a world with 3 (or more) spatial dimensions and two time-like dimensions, t_A and t_B. Note that these times have no connection to the "A- and B-series times" of McTaggart, who postulated those two types of time to correlated with either past/present/future or before/after distinctions, concluding that time did not exist [24]. Some inferences that come out in a fairly straightforward manner are that if God is to navigate this "universe" and interact with our universe without destroying it, there would/could probably be a need for several "forms" of God.[6] If one form with some "substance" could navigate in all dimensions, but resided primarily in t_B, he would risk the introduction of extremely large amounts of energy if he were to step into t_A. The reason for this is that an entity in the t_B realm, interacting with the t_A realm, could not lose any energy in the t_A realm, because no time (t_B) would have passed, so that entity could not change. If he "stuck his finger" into world A, a large or infinite amount of energy (perhaps like a column of fire?) might be discharged into A, though he would not change at all in his world, B. A second, natural and

[6] There is a risk here of being accused of heresy, in attempting to answer questions like, "Why is there a Trinity? Why not a duality, or tetrality?", rather than simply quoting scripture and saying, "That's what is written; don't ask anything further." The author's preference is for a collaborative search by science and religion scholars for answers to these obvious questions that even children ask. From some personal experience, there is also a danger in these investigations of time and our relation to the "expanded" universe, that one encounters a "fear of the Lord" that is rather suffocating. Perhaps this is not a bad thing.

"useful" form for God might be "non-substantial" and able to travel freely in all the dimensions: a "spirit". The "non-substantial" qualifier could be explored further through examination of the math behind Figure 4, but a non-material quality would certainly apply, because all materials we know about are constructed of atoms, which are held together by electric forces, operating in three spatial and one time dimension, that result in extremely stable orbits of electrons around a nucleus. Finally, at least in the Christian religion Augustine believed in, a form of God that could enter and interact with our world without much physical disruption (operating in the normal x, y, z, and t_A dimensions) would be needed, since the other two forms could not fulfill this role. Since we require that our physical description of God also encompass biblical writings, e.g., those in John 1 quoted above, this third and last form of God must also have two states: one who can create our universe (probably move independently in both the t_A and t_B time dimensions) and one who operates more like a normal human being in t_A. We find we are approaching the conclusion that a Trinity much like that described in the Bible might well be the ideal, perhaps the *only*, form for God who interacts with our world.

We have reached these quite specific inferences (or perhaps justified speculations) about the nature of God by examining the same question—"What is time?"—that caused the fire in Augustine's soul. Augustine may not have had the mathematical sophistication of modern-day physicists, but he seemed to have an instinctual sense that the transcendence and "otherness" of God had to be connected to the nature of time and time's governing nature in our normal universe.

3.2. Original Sin: Quantifying the Possible Outcomes of Human "Free Will"

A physics course targeted toward students of religion, philosophy and other major fields that commonly lead toward careers in Christian ministry has two major goals: (i) to provide basic understanding of the physical world around us; and (ii) to illustrate how physical principles can be applied to theological questions. The first goal provides the basic tools a future minister needs to more clearly see and explain the difference between unusual events and "miracles". A minister leading a congregation must apply these scientific tools judiciously, as the fragile faith of some religious believers relies on the classification of some experiences as miraculous. The main issue here is two understandings of the word "miraculous". The first meaning is connected to an event that did not and could not have occurred via normal physical processes, a meaning that seems to directly conflict with science. The second meaning less radically states that God was involved in the event. To some, both scientists and non-scientists alike, these two meanings are virtually the same, but the statement that "God was involved" does not necessarily imply that laws of physics were broken. These two meanings of "miraculous" provide the subject for endless debates, but when considered from the primary physical aspect that perplexed St. Augustine—time—some quite new issues come to the fore. These new issues can still be debated, but they first provide at least three profound questions for the science and religion students, as well as their teachers, to ponder.

(i) What is the difference between a highly-unlikely event and a miracle?
(ii) What are the limits on science's ability to project the future course of events?
(iii) Can God change what we consider the "past"?

The second question is likely to cause a good deal of unwarranted confusion, as the physics student would think of the laws of physics and their ability to predict, for example, the parabolic path of a cannonball. The liberal-arts student may, in contrast, imagine a physicist trying to predict the course of human events or the career of a new-born baby. These differing conceptions of unlikely events, past, and future, can be woven together by Augustine's questions about time.

If we provisionally accept the proposals that God operates in a second time-like dimension, independent of our own, and that our world might be viewed by God as in Figures 2 and 3, some clear physical questions present themselves. First, is there some fixed separation in time between the time "slices" of Figure 3? Second, what are the rules governing an object's trajectory from one time slice to the next. We will see that the first question focuses on whether time might be quantized and the second, on whether time might be quite different from the "flowing river" we often conceive of.

3.2.1. Quantization of Time[7]

The *simplest* interpretation of the time coordinate of Figure 3 is that time slices are separated by a constant amount, as science interprets time separations. This implies that time is quantized. The student should recall Augustine's question about the smallest-possible interval of time that can be imagined or proposed, and what that implies about actions. Current physics textbooks state that the normal laws of physics operate only for times longer than the Planck Time, about 10^{-43} s [25]. Since physical laws enforce the continuity and smoothness of the paths of objects, and these laws (probably) do not operate on times shorter than the Planck Time, we propose that the time separation between slices is 10^{-43} s. This time is *incredibly small*. Recall that we can measure times precisely to about $\pm 10^{-16}$ s, so 10^{27} of these Planck Time intervals would fit into our *very small* time-measurement uncertainty. Note that an academic class or two would have to be spent on powers of ten—scientific notation—so that liberal arts majors could easily manage the arithmetic, which, we will see, becomes a bit intense:

$$\text{Scientific Notation: } \left(10^{27}\right)\times\left(10^{-43}\right)=10^{27-43}=10^{-16} \tag{5}$$

Students will and should question this model for time and physical reality, but we almost have the minimum we need to proceed to some "theological" questions.

3.2.2. What Is the World That GOD Created?

The proposal for discussion is that God's creation is not merely the initial "Big Bang" of creation, the infinitesimal leftmost point in Figure 2 or 3, but rather the entire set of coordinates—*x*, *y*, *z* and *t*—for the entire history of our universe. He constructed the beginning, the end, and everything in the middle, from one edge of the universe to the other edge, as it exists at all times (all times, t_A, since we must distinguish it from the other time or time-like dimension, t_B, that God also operates in). Many objections will be raised at this point, but we try to postpose them and make a connection to Genesis 1:25, 31 and Genesis 2:1, where God declared that His creation was "good" and rested from His work.

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[7] We are initially avoiding the direct question of what, exactly, is this second "time-like" dimension that God operates in, but this evasion of the question is not essentially different than science has done for many years with the nature of our "normal" time.

Note that our scientific understanding of work, involving forces, distances and times, can also apply to God, but that His work involved the t_B dimension.

Let us clarify our model for how God did His creation. In Figure 3, we see that the physical universe fits together according to physical laws, which require that the paths of objects in (x,y,z) space cannot change discontinuously from one time slice to the next. More carefully stated, the discontinuity in position from one time slice to the next cannot be larger than a very small distance.

This model is difficult to comprehend clearly, but we can recall a building experience many of us had as children or as parents of children: building structures using Lego-like blocks. Again, we have to remember we are ignoring one of the three spatial dimensions, in order to incorporate the time (t_A) dimension into out model. When we build structures using such blocks, we start with the first layer. Let's refer to this layer as the first time slice. The thickness of this time slice, as well as all subsequent slices, is constant, enforced by the thickness of the blocks, and corresponds to 10^{-43} s, the Planck Time. (Ignore the thinner plate-blocks that sometimes come in a Lego set.) We note that in putting together a structure, the raised disks and cylindrical slots on the two sides of each block enforce construction rules when we pass from one layer (time slice) to the next (Figure 5).

(**a**) (**b**)

Figure 5. (**a**) a pile of Lego-like blocks; (**b**) a structure created from the blocks.

Blocks in the second layer must fit with those in the first layer: we cannot place them at an arbitrary position, or the structure will not hold together. Such positioning rules correspond to the laws of physics that describe the universe. Now, suppose we carefully follow the instruction sheet to create a panda bear, Figure 5. After hours of work, we might look at our panda and declare it a *good* structure.

It would be advisable to stop at this point to deflect some accusations of heresy and disrespect to God. The Lego model of creation is intended to allow us humans to comprehend a creation that involves all space and all time, not to assert that God is like a child playing with blocks. Even the briefest musing on the model shows that this childish creation involves numbers that bewilder even the experienced mathematician and cosmologist. How many 10^{-43}-second layers are needed to complete the universe at its present age, about 14 billion years, or $\left(14\times10^{9}\,\text{yr}\right)\left(\dfrac{3.15\times10^{7}\,\text{s}}{1\,\text{yr}}\right)\cong 4\times10^{17}\,\text{s}$? If the (horizontal) distance between the raised disks on the blocks corresponds to the Planck Distance, about

10^{-35} meters, how many blocks are needed to stretch across the entire know universe, which is something like a sphere of diameter 100 billion light years (ly): $100 \text{ billion ly} = \left(10^{11} \text{ly}\right)\left(\frac{10^{16} \text{m}}{\text{ly}}\right) = 10^{27} \text{m}$?

This computation involves four dimensions, but dealing with lengths and volumes in four dimensions is common to mathematicians and can be managed by undergraduates. The numbers are staggering and incomprehensible. Even more difficult to comprehend is the implication of the model that all of the history of the universe is presented "at the same time". There is no uncertainty of the "future"; it is already there, in some sense. If God has managed to create the universe (for all time t_A), using an incomprehensibly large number of building blocks, He will certainly know every detail, to a resolution of 10^{-35} m in distance and 10^{-43} s in time. These distances and times are incredibly smaller than the size of the nuclei of atoms and the time it takes an electron to orbit in an atom. Even if one proposed God could not remember all these details, He could find out anything He wanted, at His leisure in time t_B. In any case, we start to get a handle on why God might be so formidable and so "fearful", rather than blithely thinking that God is, well, some super being. *The fear of the Lord is the beginning of wisdom*. (Proverbs 9:10).

3.2.3. Free Will and the Tree

We strive to make a connection of the above model of creation to free will and original sin. These are quite formidable topics and have been the source for endless debate and countless essays, sermons, and books. The connection of the physical model to free will and original sin cannot be made with absolute certainty and precision—we must leave some questions for the developing ministers and physicists—but we can start.

Suppose the "panda" in Figure 5 is the creation that God declared "good". What happened in the book of Genesis after chapters 1 and 2? Genesis 3 describes the fall of man. This "fall" involves the human desire for the ability to distinguish the difference between good and evil:

> The woman [Eve] said to the serpent, "We may eat fruit from the trees in the garden", but God did say, "You must not eat from the fruit of the tree that is in the middle of the garden…or you will die."…"You will not surely die", the serpent said to the woman. "For God knows that when you eat of it, your eyes will be opened, and you will be like God, knowing good and evil." (Genesis 3:2–5).

We are usually taught that the serpent, Satan, is the great liar, and that he lied here to Eve. Most good liars know that outright lies are often unconvincing and difficult to maintain. The best lies are truths, with some subtle, essential facts left out. In the model of Figure 3, Eve's existence in our normal universe could be traced as a path or trajectory in space and time. (Consider this as before "the fall", when neither she nor Adam seemed to age and did not need to reproduce, to replace themselves if they died.) If all of existence were already in place for all times (t_A), she would have no way of knowing (experiencing) what is "good" and "evil". Her existence would naturally follow what God created and declared "good", like the panda. Note also that good is now defined as something that conforms to the *entire* creation or structure that God made, as illustrated in Figure 5, not to some debatable moral issues, like, "Should you pay taxes that support a cause you oppose?" Satan asks what

could be a higher good than to be more like God and to understand why one option might be evil, while the other is good? Shouldn't Eve want to know and understand? Does God want intelligent companions or robots? If she has no ability to actually see and accept either of two choices, Eve could not truly understand "good" and "evil", right?

We read that both Eve and Adam ate of the *tree of knowledge of good and evil*.[8] What might this tree be? It is pretty clear that after "eating the fruit", these humans could now see two (or more) options for how they might proceed. They did not blindly follow a specific path. In some way, they now had "free will": they could see two options. From a physics or mathematical point of view, this freedom of choice directly implies decision points and mathematical probabilities (likelihoods) for following a given path. If one decision offers two possible paths, and our likelihood for choosing the "correct" path were 1/2, the probability for following a particular path is $\left(\frac{1}{2}\right)^1$, or one half. A second decision point would result in an overall probability of $\left(\frac{1}{2}\right)^2 = \frac{1}{4}$ for following a specified path.

Pause. In this simplest model, we treat Adam and Eve choosing randomly, but even if they consulted experts for each decision, and each decision had a 99%, or even 99.999%, probability of being right, it would make no difference after all decision points were taken into account. This directly leads to consideration of Jesus' assertion that a camel is more likely to pass through the eye of a needle than a rich man is to enter the kingdom of heaven. In terms of the rich man's choices in life, probabilities can be calculated. Likewise, the camel's probability (real camel, passing through a real needle's eye of size less than one millimeter) can be calculated using quantum-mechanical tunneling theory. A rich man, employing many wise advisors, might have a higher probability for making right decisions. Jesus says it makes no difference. In fact, when we calculate the probability as described later in this section, we find that the camel's probability is about one chance in $10^{10^{37}}$, while the rich man's probability is one chance in $10^{10^{40}}$ (or less). The numbers in the topmost exponent may be off by plus or minus 2, but it makes no difference: the camel wins by much more than a landslide. Though no camel could pass through the eye of a needle, even if 100,000,000,000,000,000 camels try all their lives in each of 1,000,000,000,000,000,000,000,000,000,000 different universes, the rich man has an even smaller probability. In fact the ratio of the two probabilities is

$$\frac{10^{10^{40}}}{10^{10^{37}}} = 10^{10^{40}} \tag{6}$$

This calculation seems like it cannot be right. How can dividing one number by another huge number not matter? If I have $1000 and you have one one-hundredth as much, could you possibly have $1000? No, but when numbers go from familiar ranges like 1000 to incredibly large ranges like those above, dividing $10^{10^{40}}$ $10^{10^{40}}$ by $10^{10^{37}}$ $10^{10^{37}}$ is little different than dividing by 1.0001. Technically the "equals" sign in equation 6 above should be an "approximately equal to", but the exact answer,

[8] Note that the issue of times t_A and t_B, how Adam and Eve relate to them, and how they seem to have been expelled from the freedom of t_B (the Garden of Eden), are questions that must also be faced.

$10^{10^{39.999999...}}$ $10^{10^{39.999999...}}$, could not be entirely written on this or 100,000,000,000,000 pages of paper.[9] Our conclusion about the camel *vs.* rich man story? Jesus might be literally stating a mathematical fact that He would be quite familiar with, from His experience as the Engineer Who designed and constructed the universe.

So, one decision, ½ chance of success; two decisions, ¼ chance to successfully follow any pre-specified path. How many choices must we consider? We humans like to consider that what determines "good" and "evil" involves decisions we have to make over the period of a day or our lifetime. We think we have, perhaps, 10, 100, or even 1000 decisions to make per day. But this analysis has little connection to physical reality, to the intrinsic nature of our universe. It is an analysis we concoct in our minds, because it is easy to comprehend and manage. Suppose we accept the statement that the creation in Figure 5 is "good". This would imply that a particular object in that creation, which has some path that, after the fall of Adam and Eve, follows a path illustrated in Figure 3, would have a *calculable probability* of following that specific path within the overall structure of Figure 5, that God declared "good".

How many "decision points", in terms of the physical nature of our existence, does this involve? If the universe is constructed of 10^{-43}-s slices of time, the lifetime of a person would consist of about:

$$\mathrm{n} \cong \frac{(70\mathrm{yr})\left(3\times10^{7}\,\mathrm{s/yr}\right)}{10^{-43}\mathrm{s}} \cong 10^{52} \tag{7}$$

time slices. If this is the number of decision points, then the simplest estimate for the probability for following a particular path is:

$$\left(\frac{1}{2}\right)^{\mathrm{n}} \cong 10^{-10^{52}} \tag{8}$$

where $n = 10^{52}$. (Note again the unexpected mathematical results. This expression treats a human as one "object", where perhaps the reality of a human is more correctly expressed in terms of the number of individual atoms or molecules making up one's body. Since conclusions do not really depend on these details, we ignore these and other details.)

There will be many protests that we cannot be blamed for things that we have no control over, things that take place on an incomprehensibly short timescale that humans can do nothing about. But if "good", "evil", and "sin" have to do with actual structure and reality in our universe, and not just our human conception of what seems "good enough" or "not so good, but who can blame him", the comparison of the world resulting from Adam and Eve's choice to eat the fruit of the tree, to that God declared "good" is not even close. (Think of a chance in $10^{10^{40}}$ $10^{10^{40}}$.) It does not matter if 99.999% of everyone's decisions are "good", after the entirety of history, the universe we will have "created", as well as the individual life each of us will have created, will look like the left side of Figure 5, not the right side. This conclusion follows from consideration of the nature of our universe, not from a man's

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[9] In contrast to Equations 7 and 8, these numbers result from considering the decision points to correspond to the characteristic vibration time of each molecule making up a human body. Each molecule in the body must then follow a specific path, in order to correspond to a given collective path. If Equations 7 and 8 are closer to reality, the camel would beat the rich man by a factor of $10^{10^{52}}$.

perceived ability to resist taking a too-long look at the woman walking in front of him. According to our model, this is the result of Eve's and Adam's choice. This is "original sin": there is "zero" chance in a million universes, with 10 billion people in each, that even one person could follow the path that God created. It's as hopeless for the "good" person (99% correct) as for the "bad" (50% or less correct). This is what Satan failed to disclose in his proposition to Eve. There is no hope at all…unless God decided to do something.

Pause. Have we now postulated two different universes, the one God initially created (the "good" one) and the one that seems to be in the process of being created as time passes? This deserves more discussion than we have time for here, but one must be careful about asserting that our (fallen) universe is being created as our time passes. From God's perspective (Figures 2 and 3), all of t_A, from time zero to the end of time, may already be evident, so any apparent, ongoing "creation" of the universe as t_A passes may only be the view from the human perspective. We will leave to the biblical scholars whether there is written evidence for a second creation in the book of Genesis. As Julian Barbour has suggested [26], an alternative view of time (t_A), as a connecting link between the configuration of the universe at one instant to that in the next, may be a more profitable way of thinking about time.

Adam and Eve's existence before the fall is, of course, mysterious, and we cannot seek to probe the depths. If time were somehow not passing in the pre-fall Garden of Eden, or they somehow operated with some sort of "access" to both times t_A and t_B—after all, Adam walked in the Garden of Eden with the eternal God—their world must have had quite different rules of operation (laws of physics). It would seem that they would not have to eat food in order to stay alive. It appears from the account in Genesis that their bodies were not subject to the processes of decay that would lead to death. Most details cannot clearly be deciphered. However, we can make an attempt to further understand one entity: the tree of knowledge of good and evil. Why might this have been called a tree?

Figure 6 shows what mathematicians call a *decision tree*. Starting from the bottom, initial state, the object (person) encounters the first decision point. We assume two possible choices at each decision point. The probability for making a *left* or *right* decision can be specified, but we assume ½ for simplicity. A pre-selected path is shown in red. The calculations we have been doing correspond to finding the likelihood that an object (person) starts at the bottom and follows the selected path all the way to the top. Each time (vertical line segment) in the tree corresponds to the Planck Time.

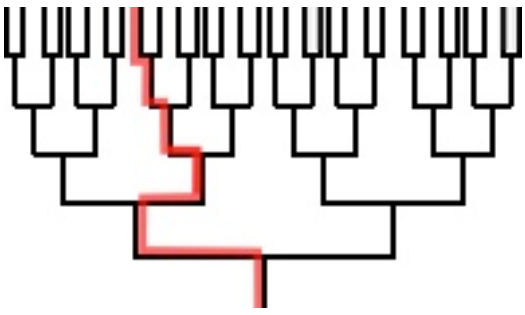

Figure 6. Decision tree. Time starts at the bottom and increases in the vertical direction. Two possible choices are assumed for each decision.

We will not try to defend this view of the *tree of knowledge of good and evil*—it is a bit speculative—except to say that it incorporates the ability to choose good or evil, allows one to actually calculate probabilities, and conveys more understanding than a picture of a common apple tree.

By this point, the author expects that the majority of science, religion and philosophy students, as well as faculty, will be powerfully offended by this model for God, creation, and existence. However, the downfall of a scientific model cannot be based on our sensibilities being offended, but on shortcomings of *simplicity and clarity*, *explanatory and predictive power*, and on *experiment and observation*. We do not have time to explore these issues here, but note that already, we have produced a calculation of the likelihood of a rich man "entering the kingdom of God", and compared it to the likelihood of a camel passing through the eye of a needle, and found that Jesus' comparison of the camel and rich man just might have been a literal statement about the physical operation of the fallen universe and humans, by the person who created it all. If we consider Jesus' statement as a legitimate experimental observation, then this model satisfies the primary requirements of science. The many issues that remain to be clarified require the collaboration of scientists and theologians. Imagine: not a debate between scientists and theologians who are each convinced of their position, but a collaboration of scientists and theologians, none of whom sees how the details of science and theology quite fit together, all of whom are disoriented, but know they need the help of the other side. Augustine might not have been surprised at such an intersection of interests, but collaborations in mainstream science and religion are not common today.

4. Power, Miracles and Changing the Past (?)

Power is a standard subject that both physicists and religious ministers teach in elementary educational courses or sermon series. In the context of the nature of God, Christian ministers and believers may state, "God can do anything He wants", when questioned about the rarity of obvious miracles such as those recorded in the Bible. The statement is usually accompanied by assertions that there are many miracles we don't even notice, like life itself, or a radical change in the health, lifestyle, or attitude of a friend or relative. There may be comments about God dealing with humanity in different ways during different periods of time (dispensations?), or an emphasis on "anything *He* wants", as opposed to what human onlookers might want to see. What people mean by "miracles" is also usually limited to phenomena or situations they have encountered or read about.

One example of God's ability to do miracles, but refusal to do something He does not want to do, can be found in the biblical description of Jesus' temptation by Satan, after Jesus had fasted for 40 days and nights (Matt. 4). Satan first challenges the very hungry Jesus to change stones into bread. Jesus waves away the challenge, quoting scripture, "…man does not live on bread alone…" The obvious implication is that such a miracle is not anything that Jesus or God particularly wants. In his second temptation, Satan transports Jesus to the highest point of the temple, and, after quoting scripture (Ps. 91:11ff), challenges Him to jump off, asserting that God will command angels to rescue Him. Jesus replies with, "Do not put the Lord your God to the test." (Matt. 4:7, NIV) Some translators have offered "tempt" as an alternative for the word "test". The author is not a competent translator, but consideration of the possible limitations on what God may do, in the context of the above model of time and existence, points a clear finger of preference to the "testing" translation.

Why does Jesus invoke a prohibition on "testing" God, when challenged to jump off the top of the temple? The drop would have been about 100 feet, according to a note on Luke 4:9 in my 1985 Zondervan NIV Study Bible. In any ten-year period, most of us would have heard of cases where people have fallen out of high windows and survived almost uninjured. Perhaps Jesus is simply brushing off Satan's challenge as trivial: such a miracle would not seem to be a major test of what God could do. However, if Satan is really as wily as described in the Bible, there may be more to the "test" than appears.

Figure 3 provides us with a tool to analyze at least certain types of "miracles". A miraculous event occurs in the right-most diagram of the figure, where an object is at one position at one time, and at a distant location in the next time slice. This violates the laws of physics, and movement even approaching such a rapid translocation would require the input of a near-infinite power that would tear the universe apart at the point of application. This is not something God would likely want to do. We have arrived at an initial example of what might "limit" God's actions: He will (probably) not do certain miracles, if the result of the miracle would be the destruction of our universe. God could, however, accomplish a rapid-enough translocation of an object to accomplish the goal, which may be to move a child out of the way of a speeding bus, without the need to apply a huge power that would destroy the universe. Given enough forewarning, God could even use a nearby pedestrian to knock the child out of the bus' path.

We have just used a critical phrase that Augustine has already considered: "…compare it with the times which are never fixed, and see that it cannot be compared; and that a long time cannot become long, but out of many motions passing…but that in the Eternal nothing passeth, but the whole is present." (See Introduction). "Enough forewarning" implies that God needs a certain amount of time to do certain things, and that if He intervenes too late, explosive results might occur. An obvious way out of this apparent dilemma is to say that God is never taken by surprise, so He will never be in a position to intervene too late. Is the issue then at its end?

If we take Figures 2 and 3 as a possible way God might "see" our universe, we reinforce our conclusion that God is never taken by surprise: He can, at an instant in time t_B, "see" any event that takes place from the beginning until the end of our time, t_A. He could then intervene at precisely the right time (t_A) and place. In fact, He could intervene at a time 1 second before a possible desired translocation of the object in Figure 3c. This would mean He would have to adjust a few times 10^{43} of the 10^{-43}-second time slices, in order not to produce a discontinuity that would disrupt the universe. This is not so startling, if we have accepted the idea that God can manage $10^{10^{50}}$ objects without a problem.

However, there is another possibility, one that may have lurked behind some of St. Augustine's fiery desire to understand God, time, past, present, future, and eternity. We present this possibility, and then end this paper. If God truly constructed our universe from building blocks that correspond to small intervals of x, y, z, and t, He could intervene and change the local structure of our universe in a manner that would not disrupt its stability. For example, a cancer-ridden ovary could be somehow modified in a way that the cancer would not be there a week later. The intervention by God might be over a period (t_A) of two weeks. Many Christians would have no problem with these statements, except to wonder about the "two weeks", *vs.* the "a week later". This apparent discrepancy is intentional.

What if one of the two "modified" weeks is in what we consider the past? *Can God change something in our universe that we consider "past"*? Note that this is not the same as proposing time travel of an object or person in our universe. God is simply rearranging building blocks. Is there a problem? Is God limited to changing the future? Is this question part of the fire in Augustine's soul?

5. Conclusions

This paper presents a proposed physics course curriculum related to time and eternity as described by St. Augustine in several of his works, as part of a physical theology course or educational module designed for upper-division undergraduate religion, philosophy, and science students. The course could satisfy a core science requirement. The focus is on physical reality, as dealt with by most physicists, and on the nature of God, not on religion, religious practice or morality. The objective of such a course is to provide students with physics tools capable of quantitatively addressing questions relating to common observations in our normal world and to the interaction of eternal God with our world, as described in the Bible. Quantitative tools include those of numerical calculations. The level of the physics is that of an introductory college physics course, but the presentation of the laws of physics focuses on a pictorial/graphical description of the laws in terms of model diagrams in x, y and t coordinates, with the z spatial dimension suppressed for convenience. An object following the laws of physics follows a smooth, continuous path. The proposal to bring God into the same model via the simplest assumption that allows His "activity" and "unchanging" nature, along with unchanged physical laws in our universe, introduces a second time or time-like dimension, t_B, in addition to our normal time, t_A. Like our normal time dimension, the detailed nature of this second time need not yet be specified, other than to note that "free" access to both time dimensions is restricted by considerations of predictability and stability. As with any legitimate physical model, the one proposed enables quantitative predictions and explanations of common, but difficult, biblical issues like original sin, free will, the camel/rich man story, *etc.* The model treats experiments and observations in the normal world, as well as biblical writings as valid "data" that model predictions must conform to. This results in an alternative way to read and interpret scripture in a very literal sense. The approach can produce quantitative explanations (not physical analogies) but should be considered a hermeneutical method, to be added to those already available to students of biblical, philosophical and theological literature.

While presentation of the normal laws of physics is slightly unorthodox compared to mainstream "College Physics" textbooks, the principles are the same and should not be controversial. The proposed second time dimension is not part of conventional physics, and should be carefully dealt with, as should the view that our normal time is simply the directional "glue" that stitches one instant of existence to the next and previous. Physicists should take issue with the proposed presentation of time(s), though no violation of normal physical laws results. Theologians and philosophers may take issue with the model's restrictions on their freedom to interpret scripture, God and reality as they see fit, but such restriction is the purpose of a physical model. Physical laws restrict assertions of "Anything goes". A course goal is to engage both scientists and theologians in exploration, not debate, of some of the model's suggestions, a few of which follow.

- Interpretation of scriptures (e.g., the camel *vs.* rich man comparison) can be done in a literal, simple, physical way that produces additional quantitative understanding.

- God may have freedom to alter the past, with no violation of physical law.
- A "miracle" should be not be defined as a phenomenon that violates laws of physics, but rather as series of events that would not and could not have occurred without the activity of God (e.g., see previous suggestion).
- "Possible" and "impossible" should be considered from a probability perspective: should one chance in 1,000,000 be considered "possible"? One chance in $10^{10^{50}}$?

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Abbreviations

3D: 3-dimensional;
2D: 2-dimensional;
m: meter;
s: second;
yr: year;
ly: light year.

Conflicts of Interest

The author declares no conflict of interest.

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