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Physics and "The Ainulindalë": The Greatest Creation Story Ever Told

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INTRODUCTION

Most religious and spiritual traditions claim to have had some communication with a Creator. This communication often includes a creation story, in which the origin of the world and the relationships between the Creator, Creation, and humanity are characterized. To the cultures in which they originate, these creation stories are sacred mythic narratives, handed down across generations from the first people (witnesses to the creation), or told to humanity by the Creator and then passed down.

Although creation myths are rarely expected to contain facts in the scientific sense, they do attempt to convey truths about the role of humanity in the Creator's cosmos, e.g. humans are an accident (vomited up by Bumba in the Boshongo creation myth), or the very purpose of creation (created in God's image in the Hebrew creation myth). Creation myths make truth claims in that metaphorical and symbolic context: that the Creator, Creation, and humanity are related to each other in certain ways conveyed by the creation story.

A survey of dozens of creation myths suggests that none of these claims about the relationships between Creator, Creation, and humanity are likely to be informed by communication with the Creator. While they may contain truths found by human insight, all of them fail to notice these details that would be obvious to a non-ignorant Creator: that music is built into the physics of the universe (literally), and built into humanity (both literally and metaphorically).

The major chord is built into the physics of a vibrating string, and human infants possess musical skills, yet no Creator communicates authorship of these aspects of Creation. If one is willing to accept modern creation stories as peers to their ancient predecessors in metaphorical and symbolic truth-telling, this omission can be cured, after thousands of years of creation-story telling. J.R.R. Tolkien's *Ainulindalë*

depicts a musical creation in the first chapter of *The Silmarillion*, illustrating a relationship between music, Creation, the created, and the Creator. Despite his failure to make the claim, Tolkien's creation story has a greater chance of being influenced by the Divine than its predecessors. The *Ainulindalë* explains why there is music built into the fabric of the universe and humanity: because the Creator made it so.

In the sections that follow, I will summarize the *Ainulindalë*, describe how the major chord is more a discovery of physics than an invention of art, note recent investigations into the biology and archaeology of music, and discuss the absence of music-aware creation stories.

TOLKIEN'S *AINULINDALË* IS A MUSIC-BASED CREATION STORY

The creation story of Middle-earth told in *The Silmarillion* (Tolkien, 1977) is explicitly music-based. Music is part of the mechanism of creation, and musical concepts such as dissonance are used to illustrate themes common to other creation stories, such as why there is strife in a world created by a benevolent Creator. That the *Ainulindalë* has musical themes throughout is a trivial observation, but for readers who have not encountered the *Ainulindalë*, a brief summary follows:

Eru Ilúvatar ("He that is Alone"/"Father of All") creates the Ainur (godlike and angelic beings) from his thought, and the Ainur spend their time singing solo or in small groups. Ilúvatar proposes a mighty musical theme to the Ainur. The Ainur improvise on and around the theme, adding their own creativity to the music as Ilúvatar listens. Dissonance is introduced as one of the Ainu, Melkor, struggles to control the music. Some of the Ainur leave Ilúvatar's main theme and sing along with Melkor, until the music becomes raging and turbulent. Ilúvatar adds a second theme, but Melkor's struggle for control again produces a war of sound. Finally, Ilúvatar declares a third theme that Melkor is unable to spoil, even incorporating elements of Melkor's efforts into the most-triumphant notes. The music ends, and Ilúvatar shows the Ainur a vision of the World, which unbeknownst to them, they had scripted through their music. The preview ends, and Ilúvatar makes the World as a manifestation of the Music. Many of the Ainur go into the World to help shape the creation. Snowflakes and rain are examples of Melkor's attempts to ruin water with cold and fire: as with music, conflict and dissonance still result in beauty. Elves and Men are products of the third theme, and their part of the music was created by Ilúvatar himself, not by the Ainur.

MUSIC IS BUILT INTO THE UNIVERSE

While it may seem that music is a human cultural product, this is only partly true. Human culture certainly affects musical taste, instrumentation, and other aspects of the human experience of music, but music is more of a human discovery than an invention. The basic building blocks of music result from physical phenomena that could be independently discovered on a planet orbiting a star in the Andromeda galaxy, just as it was on Earth. A discussion follows of the physics of music and how some music theory naturally follows from the physics, but of course each subject is deep enough to occupy a lifetime of

study, and many complicating factors have been omitted for brevity. While the material that follows is well-covered by modern popular references (e.g. Daniels, 1990), the concepts were also known to Pythagoras (570-495 BCE).

A fairly simple definition of music is that it is a rhythmic arrangement of tones. We hear these tones when pressure oscillations in the air cause fine hairs in our inner ear to vibrate, sending signals to our brain that are experienced as sound and music. When a string on a guitar is plucked, it vibrates back and forth in periodic motion at a *frequency* determined by its length, mass, and the tension on the string. If the length is halved, the frequency of vibration doubles. If the length is reduced to a third, the frequency triples, and so on.

When a guitar string is plucked, most of its energy is expressed as a standing wave that is the same length of the string. In addition, standing waves are generated along the string that simultaneously result in the string vibrating in half ($\frac{1}{2}$), in thirds ($\frac{1}{3}$), in fourths ($\frac{1}{4}$), and so on – integer fractions of the original length (which can itself be expressed as $\frac{1}{1}$). These fractional vibrations are called *harmonics*. Standing waves of non-integer fractional lengths do not develop, because they are disrupted by the string geometry. The combination of the main note, these harmonics, and their relative loudness results in the characteristic sound of different instruments, which is why the same note played on a guitar, cello, and piano are easily distinguished from each other.

On a guitar, harmonics can be demonstrated by plucking the string while lightly touching the string at the midpoint (12^{th} fret), at one third the length (7^{th} fret), one quarter (5^{th} fret), and so on. The main frequency (or *root note*) gets diminished in volume, making the harmonics stand out. A careful listener can even hear the harmonics without damping the root note – they are revealed, not induced, by the damping of the root note. In fact, these harmonics are present even if the string is vibrating in a vacuum – but they are inaudible without an atmosphere to transmit them to our ears.

In music theory, an *interval* describes the relationship between two notes with different frequencies. If the second note has a frequency of double the root note's frequency (the result of halving the string length), that interval is described as "an octave above". If it is half the root note's frequency (twice the string length), it is "an octave below". The note an octave above the root note sounds so similar to the root note (because of how closely the standing waves align) that in musical notation, it is given the same name (e.g. "middle C", "high C", "low C"). Intervals whose frequencies are related by simple integer fractions ($\frac{2}{1}$ for the octave) result in smoother oscillations that reach the ear, and are perceived as pleasing by the listener. Intervals related by more complicated fractions (e.g. $\frac{4457}{3313}$) cause more-complicated oscillations, and are perceived as dissonant. Dissonance plays an important role in music, so it is oversimplifying to describe dissonant intervals as "displeasing" – context is everything.

If one plays the note known as "middle C" on a piano, the mechanism will strike a string that vibrates 261.6 times per second; for simplicity, we will call the middle C frequency "*f*". If we play an ascending scale starting at middle C (CDEFGABC), we call that root note the "first" interval (*f* multiplied by 1, or 1*f*), the next white key to the right plays the "second" note compared to the root, the key to the right of

that plays the "third" compared to the root, and so on up to the eighth key. The eighth key (hence "octave") plays a note at double the frequency of the root note, 2*f*. When the root, third, and fifth notes are played together (C, E, and G in this case), that is called a "major chord", and it is a basic building block of music, present in all cultures, whether ancient or modern.

The third and fifth intervals are not arbitrary choices of frequency relationships. These intervals are found in the harmonics of a vibrating string. Each successive doubling in frequency makes a note one octave higher, so frequencies of 1*f*, 2*f*, 4*f*, and so on are increasingly higher-pitched C notes. These notes can be sounded with guitar harmonics by lightly touching the string at the appropriate fractional lengths ($\frac{1}{1}$, $\frac{1}{2}$, $\frac{1}{4}$). As mentioned previously, the string can also sound harmonics when divided into three or five parts, resulting in frequencies of 3*f* and 5*f*. The note at 3*f* is a G up an octave from middle C. We can make another G note that is closer to middle C by lowering it an octave, to $\frac{3}{2}f$. Similarly, the note at 5*f* is an E two octaves above middle C, and we can lower it two octaves to $\frac{5}{4}f$.

After all that, we find ourselves back at the major chord (C E G), with three notes that sound very pleasing when played together, because the combination of their frequencies results in relatively simple pressure oscillations reaching our ears. The oscillations are fairly simple because the note frequencies are related to the root note by the simple fractions of $\frac{3}{2}$ and $\frac{5}{4}$, and the resulting sound waves align with each other in ways that complicated fractions cannot. Every time a string is plucked, the harmonics in the vibrating string quietly play a major chord. In short, physics determines the basic principles of music theory, because music is built into the physics of the universe.

MUSIC IS BUILT INTO HUMANITY

Even a casual observer will notice that music is universal in human culture. No examples of nonmusical cultures have been found by anthropologists (Merriam, 1964). Humans have music for every emotion, every occasion: elation, rage, dancing, laughing, weeping, worshipping, warfare, loving, healing, mating, creating, learning – it would be far more efficient to produce a list of non-musical emotions and occasions, if an example could be found to begin the list.

Music is not only universally present in human culture, it is capable of transcending cultural and temporal barriers. Modern English speakers are incapable of understanding the text of *Beowulf*, despite reading and speaking a language descended from *Beowulf's* Anglo-Saxon, and would find the evening news presented in thousand-year-old Anglo-Saxon to be incomprehensible. Modern music listeners have no such difficulty, and bought over 6 million copies of a Gregorian chant album – a recording of music that was contemporary with the author of *Beowulf* (*Chant*, a 1994 release by the Benedictine Monks of Santo Domingo de Silos).

Music is a deep-rooted part of the human experience, but until recently, this could easily have been misunderstood as a social construct, a product of cultural norms. While it is undeniably true that musical

preferences change with culture, peer groups, and personal experience, the human affinity for music is inborn.

Peretz and Hyde (2003) summarize recent research into musical abilities as follows:

> "Neurologically intact individuals appear to be born musical. Before one year of age, the pre-linguistic infant displays remarkable musical abilities that are similar, in many respects, to those of adults. … Musical training or explicit learning of music theory appears unnecessary to acquire sophisticated knowledge of the syntax-like relationships among tones, chords and keys."

Six- to nine-month-old infants detect mistunings in invented musical scales (i.e. the infant cannot be reacting to prior familiarity with the scale), prefer steady tempos, and consonance over dissonance. Tone-deafness ("amusia") is caused by a failure to develop fine-grained pitch perception, and is 70-80% explained by genetic factors when identical and fraternal twins are compared – we are quite literally born with inherent musical abilities. Besides music, no other use has been identified for this fine-grained pitch perception – even tonal languages use variations that are coarse enough that the tone-deaf can perceive and reproduce them. We are born musical, and we don't know why that is.

Recent archaeological work sheds light on humanity's musical birthright from another angle. A carbon-dating examination of flutes made of bone, found in Germany's Geißenklösterle cave, gave ages of 42,000 to 43,000 years ago. Reconstructions of the flutes can be played, and they are tuned to a recognizable scale (diatonic; Münzel et al., 2002). These flutes were not simple noise-makers for catching someone's attention at a distance, like a referee's whistle – they were built for making music, with frequency relationships that are still in use today.

In case those dates do not seem remarkable enough, here are a few examples of events much more recent than the last time musical notes were sounded on these flutes:

- 18,000 years after the bone flutes were made, *Homo neanderthalensis* died out
- 30,000 years after the flutes, *Homo floresiensis* (nicknamed "hobbits" for their small stature) went extinct, leaving *Homo sapiens* as the only remaining humans
- 31,000 years after the flutes, agriculture was invented with the domestication of plants and animals

It is not simply the case that humans are born musical – it is not much of a stretch to say that humanity itself was born musical. We have been making music for at least 43,000 years, with instruments not all that different from those in use today.

CREATION STORIES DON'T NOTICE MUSIC

Leeming (2010) presents a definitive collection of creation myths, summarizing and analyzing creation stories from 123 cultures (plus variations within cultures). The mechanisms and materials of creation vary widely, including: speech, drops of dew from the void, dismemberment, popping into existence, being born out of darkness, a cosmic egg hatching, dropping a stone into water, pregnancy, primordial waters which already exist, transformation of existing materials, sculpting, vomiting, pushing gods apart, defecation, primordial wind, and even aliens.

Sound is an element of some creation stories, usually as speech, but also as the cry of a bird (Thebes), the sound of a reed beating (Australia), crackling fire (New Guinea), beating a drum (Pacific Northwest), and a raven singing to a clam to call people out (Haida). On the rare occasions when music is used in creation stories, it appears to play a minor role. In the Haida example above, the raven hears noises inside a clam and sings to ring them out – the people already exist, the clam already exists; the music is communication, not creation. The poet Amairgen sings the Ireland of the Celts into existence, but in an already-populated world that includes stops in Egypt and Spain. The Hopi Spider Woman and Tawa use singing to bring animals and people to life, but only after forming them of clay and covering them with a sacred blanket; furthermore the Eternal Waters also seem to predate the Hopi creation.

This is not to say that music is unimportant in the context of worship – much to the contrary, music is a prominent component of worship rituals worldwide. Some sacred texts are literally the words to songs (e.g. Hebrew Book of Psalms). The "church mode" arrangements of tones are so named because of their origin with monastic music theorists. However, these all appear to be relatively late developments driven by human motivations, not by divine commands from the beginning of humankind. It seems that the Creator learned about music from humankind, not the other way around.

In fact, so little attention is given to music in creation stories that it is baffling. Why does the Creator appear unaware that music is built into Creation itself, in the physics of a vibrating string (or flutes and pipes, with similar physics)? Why does the Creator appear unaware that humans are musical, down to their biology? There does not appear to be any sacred symbolic meaning to the ratio of root and fifth ($\frac{3}{2}$), nor root and third ($\frac{5}{4}$), despite tens of thousands of years of human experience with them in a musical context. In creation stories, the Creator is often found taking credit for Creation, yet does not mention the universality of music in the context of physics nor in the human experience. It is a very prominent omission from the conversation between Creator and Created.

TOLKIEN'S CREATION STORY NOTICES MUSIC AND ITS SIGNIFICANCE

It would not be difficult at all for a Creator to have claimed credit for music. As we have seen, humans are attuned to music as infants, and have been so attuned for tens of thousands of years. The physics of music are a fundamental feature of Creation, and cannot be escaped through time or distance. A Creator

could have taken credit for music in various ways, whether claiming it as an artist's signature on a masterpiece, a reassurance about the goodness of Creation, a salve for an otherwise difficult existence, or as a direct command to worship with music in imitation of a Creator that put music everywhere physics can reach. Instead, across dozens of creation myths, the Creator appears uniformly ignorant of the physics, biology, and culture of his/her creation.

These problems remain only if we restrict ourselves to long-ago creation stories. If instead, we can accept that a modern creation story can illuminate the relationship between Creator, Creation, and created, then the *Ainulindalë* may be acknowledged as bearing greater truth than its numerous predecessors. For the first time, metaphorical and symbolic truths about humanity's 43,000-year-long relationship to music, and the inherent musicality of Creation, have been incorporated into a creation myth. By showing in the *Ainulindalë* that the musical signature of a Creator is written everywhere and everywhen, Tolkien authored something that he may never have intended: The Greatest Creation Story Ever Told.

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