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Secular Salvation: Sacred Rhetorical Invention in the String Theory Movement

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SACRED RHETORICAL INVENTION IN THE STRING THEORY MOVEMENT

by

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String theory is argued by its proponents to be the Theory of Everything. It achieves this status in physics because it provides unification for contradictory laws of physics, namely quantum mechanics and general relativity. While based on advanced theoretical mathematics, its public discourse is growing in prevalence and its rhetorical power is leading to a scientific revolution, even among the public. By presenting a history of continual discovery of extra dimensions, string theory proponents draw upon key thinkers in physics such as Theodor Kaluza and Albert Einstein and frame them as pioneers for the emergence of string theory.

Popularization of string theory is grounded in the employment of rhetorical forms of sacredness. Proponents of the theory present a history of the theory as a linear progression of scientific discovery, culminating in specific events that establish the theory as significant scientific discoveries. In the presentation of the theory, string theory supporters engage in strategic romanticizing of the key people and events surrounding they theory. The contradictory conventional paradigms of physics make up the problem string theorists set out to solve in public discourse. The result and theoretical foundation of this study resides in the rhetorical potential by which the sacred becomes a translatable resource for popular science in the presentation to public audiences.

This exigency of division is the first step of persuasion and is expressed in a discourse of division. Because of division, unification is the goal of physicists and the term becomes rhetorical term for the theory's proponents.

Arguments for string theory as the Theory of Everything are grounded in rhetorics of faith, prophecy, theoretical Armageddon, and Millennial peace. The religious nature of the rhetoric, upon closer examination, gives us something unique in the string theory narrative: a secular salvation. Rhetoricians justify the importance of unification, which then allows the appeal for the Theory of Everything to be the conclusive argument. The implication is a secularized salvation story.

Dedication

My wife has lived in small apartments with little money for ten years to support my dream of becoming a professor. Although she says that the sacrifices have been for the future of our family, I know it has not been easy for her. She put her own education on hold to support mine. This project is a culmination of my research, but at the heart of it we find Celeste's perseverance.

Acknowledgements

In summer 2008 I came to Dr. Lee with an ambitious idea. I had already decided that I wanted to situate myself in the fraternity of thinkers who are passionate about scientific discourse. Yet I was hesitant and worried what his reaction would be when I first argued for a rhetorical analysis of string theory for my dissertation. As a listener who has a reputation of supporting people in their ambitions, he showed the same zeal for the project that was stirring in me. In time we found ourselves working to understand the sacred form it often employs while trying to simultaneously figure out what exactly string theory is. Dr. Lee so often told me to "keep the faith" and it was encouraging. He kept me going when I worried that I was out of my bounds in trying to take on such an unexplored topic in our field. Being a man who lives up to his word and practices what he preaches, his faith in the project sustained mine. I cannot help but think that his journey in advising this project must have been one that included developing faith in me and this unique project. Carried by his insistence that I give keen attention to detail and writing in a narrative form, we made it to the end. But for me, the journey has been about much more than the analysis of the public discourse of string theory, it has been about gaining a friend who had faith in me, and in whom I am in debt for his encouragement and interest in my work. He is an example not only of a rhetorical scholar, but an advisor who demonstrates in his life what it means to be a leader. To branch away from the details of how we used Plato in this project, Dr. Lee is, in the classic dialogue, what Socrates would have called a true Statesman.

Dr. Pfister has supported this project from the beginning. He has been a guide and a reference. I'm grateful to have him on my team. When Scott Church and I were eating

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Dr. Krone has been an important element of my doctoral training. I appreciate her perspective on the study of communication and her interest in my progress. The numerous graduate seminars I spent learning about organizational communication theory from her not only challenged me theoretically and broadened my capacity for intellectual inquiry, but made me a more holistic scholar when I was on the job market.

Failing to recognize family support is necessary. My parents must be acknowledged. I grew up watching my parents demonstrate the kind of work ethic that is essential to the completion of a doctorate. My parents' work habits still amaze me. I want to be like them, but I know that I'm not there yet. They have been supportive and interested in this journey. My wife, kids, and parents were the first people I called about my completion of the dissertation. They are as thrilled about its completion as I am.

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Chapter 1

The Popular Story of String Theory

String theory is shifting the way we understand the universe. This new scientific idea is based on complex laws of physics that challenge the makeup and behaviors of elementary particles. Its advocates frame it in an easily comprehensive way that is designed to be read and understood by everyone, not only scientists. The findings in this theory challenge established ideas in physics by heightening the inability for previously proven laws of nature to fit together, and by establishing string theory as a new paradigm for thinking about physics. The rhetorical power of this scientific movement is in how the mind-blowing ideas of string theory are accessible to the vernacular reader in popular scientific discourse through popular press literature and documentary film.

This new theory is based on two new ideas that there are multiple dimensions of space. First, the mathematical equations of the theory imply that there are eleven dimensions of space in the universe, as opposed to the three which we experience (up-down, left-right, back-forward). Second, the theory’s proponents argue that the most elementary parts of nature are not atomic particles, but vibrating strands of energy which have been named “strings.”

In this dissertation, I explore the rhetorical resources employed in the presentation of the theory to the general public through popular literature and film. In order for a new idea to challenge and replace already established theories, the power of persuasion must be utilized. As its advocates tell the history of physicists discovering the existence of multiple dimensions and of string particles usually by accident, string theory is presented to audiences as the explanation of the universe. Within the narrative is the personification of nature; it seems nature itself is laboring to introduce itself to humanity. The story is also accompanied with a common argumentative structure of how the theory works as the ultimate theory that brings closure to the challenges physicists have faced in attempting to fit the laws of physics together.

This chapter is an overview of the common story told by proponents of the theory. The first inklings of string theory emerging into the minds of physicists began in the early twentieth century. As the story unfolds we find that it would emerge again and again, culminating in an ultimate discovery in 1984. The success of string theory is connected to the historical tradition of physicists' attempting to provide a unified theory of the laws of nature. As the world of physics already had the dream of unification in its research agenda, string theory is explained as being the final answer to contradicting theories of nature.

Following the overview of the string theory story emerging as a promising and popular theory of physics in chapter 1, I discuss scientific rhetorical invention and the theological, mythical nature of public scientific discourse. I then perform a three part analysis of the argumentative structure that makes string theory discourse work at a vernacular, public level of understanding the universe. That argumentative process begins as writers first ensure that audiences understand the division that is present in prominent theories of physics. These discussions of division function to create urgency on the part of audiences. The solution to division is then presented: string theory is the ultimate unifying theory of nature. The final analysis is an exploration of the phrase "Theory of Everything," which is grounded in sacred notions of language. To get there, we must first understand the history of the theory and why the story of string theory functions as a rhetorical recreation of the laws of the universe not only for physicists, but for everyone.

Although still in its infancy as a theory--only thirty-seven years old according to physicist Michio Kaku (2005)—there is an enormous amount of popular literature dedicated to the subject of string theory. Physicists Paul Davies and Julian Brown (1992) make this point of providing a common understanding very clear in their book, *Superstrings: A Theory of Everything*,

> The intention of this book is to give both physicists and interested non-physicists an insight into the essential ideas of string theory . . . Although the subject of superstrings is still in a state of rapid development, the essence of the theory is now well established, and we hope that this book will provide a useful and entertaining snapshot of what could turn out to be one of the great scientific advances of our age. (p. viii)

The beginning: the challenge of association with mysticism

I begin my telling of the string theory story by drawing upon an event surrounding a mystic named Henry Slade. This tale is told in only one piece of string theory literature I examine. The reason it is so isolated is because the claims which later became associated with string theory were, in the story of Henry Slade, associated with mysticism. As theoretical physicist Paul Halpern (2004) explains, the idea of extra dimensions of space was a taboo topic for physicists in the nineteenth century. And in the contemporary telling of the string theory story, string proponents do not want to be associated with mysticism.

Yet it is important to include this story anyway. I am interested in the theological use of language in the construction of the new universe that has extra dimensions of space. Therefore, early connections to mystical notions of the universe are of special interest to this project, and demonstrate how no matter how much scientists wish to take scientific claims away from religious notions, the creation of sacred language is inevitable, whether scientific or not. Starting with the Slade story helps us realize that even at the earliest inception of the ideas which would decades later be referred to as string theory, the rhetorical connection to theological notions are ever-present. At the end of chapter 1, and especially at the end of this dissertation, it becomes clear that science cannot avoid the use of a rhetoric of religion—one of the points that is demonstrated in this dissertation.

The idea of an extra dimension of space was first based on an assumption, not mathematical calculation. Halpern doesn’t state exactly where this notion started, but discusses its presence in the age of mysticism in late nineteenth century Europe. At that time the possibility of a fourth dimension of space was prominent, not only among physicists, but elsewhere. In England there were tales of ghosts, fairies, and witches dwelling among the people. At the same time, science was spreading throughout the world and the age of the Enlightenment had brought with it the rapid spread of zeal for rationalism and the dismissal of mysticism. The capacity to reason was associated with the ability to question assumptions of the metaphysical, and of belief in anything beyond what could be understood through empirical observation.

In 1877 the two worlds of mathematical reason and metaphysical exploration met, were almost united, but were quickly dichotomized by scientists who disdained any discovery that would be associated with mysticism. That year German physicist Johann Zollner watched Slade perform impossible feats. He was stunned by Slade's ability to do the impossible. Slade linked solid wooden rings together, transported objects out of a sealed container, and removed knots from a rope whose ends were tied together. Zoller believed he was seeing evidence of the existence of a fourth dimension.

Certain that this was evidence of a fourth dimension, Zollner defended Slade's work in a court trial where Slade faced charges of fraud. With Zollner's support, this event linked science and the paranormal as Zollner's role in the trial created a following for Slade and his hypotheses. In 1882 the Society for Psychical Research was organized. This society devoted itself to the scientific study of paranormal experiences, based on the existence of a fourth dimension.

As time went on, physicists grew increasingly embarrassed by scholars like Zollner who were consumed by the study of such mystical nonsense. In his discussion of the event, Halpern quotes the disdain of twentieth century Scottish physicist James Clerk Maxwell, who satirized physicists and mathematicians who were exploring the ideas of multiple dimensions.

My soul is an entangled knot,
Upon a liquid vortex wrought
By Intellect, in the Unseen residing,
And thine cloth like a convict sit,
With marlinspike untwisting it,
Only to find its knottiness abiding;
Since all the tools for its untying

In four-dimensioned space are lying
Wherein they fancy interspaces
Long avenues of universes,
While Klein and Clifford fill the void
With one finite, unbounded homaloid,
And think the Infinite is now at last destroyed. (p. 6)

From then on, Halpern explains how the idea of extra dimensions came along with the dark cloud of mysticism in the world of physics. Physicists came to focus less on mathematical maneuvering to discover the laws of nature, and began to focus more on experimentation. As I mentioned before, the tale of Zollner and Slade is not widely told in the string theory tale, but Halpern's description of the story in popular string theory literature is significant because it explains the historical challenges that arose for any physicist who would attempt to explain the laws of the universe under the assumption of extra dimensions.

Most string theory writers begin with the discussion of Theodor Kaluza, who I discuss below. Yet I want to emphasize how historically religious notions of explaining nature were present even in the Enlightenment. Attempts to link religious deity with the natural world were the norm. Such was the case the work of Enlightenment philosophers Thomas Sprat (1734), Joseph Priestly (1777), and Leonard Euler (1795). But in the twentieth century, experimentation ruled and rational mathematical equations which suggest extra dimensions of space were not seen as scientifically rigorous. This becomes more apparent as the story moves to the first breakthrough in ideas which would become associated with string theory.

The shift away from theological understandings of the laws of nature comes from resistance to arguments that the extra dimensions are the residing place of ghosts, or even of God; the kind of claims which Zollner's work implied. The fear of scientific formulation being associated with such assumptions created worry in the larger physics community. Amidst the dream of some Enlightenment thinkers to move away from religious assumptions, a tradition that was disdained by some Enlightenment thinkers such as Voltaire (1794), the formulations of extra dimensions of space were constantly rejected. Such is the case of the story of Theodor Kaluza. Kaluza had clear and convincing mathematical reasons for believing in the existence of extra dimensions of space, yet he never saw it come to fruition due to the resistance within physics.

The Kaluza-Klein miracle

After the Slade trial, nothing significant happened until 1919. Halpern calls the real impetus of string theory the "Kaluza-Klein miracle" (p. 3). This is a reference to the contributions of the German mathematician Theodor Kaluza and Swedish physicist Oskar Klein.

In 1919 Theodor Kaluza was working as a humble *prizatdozent* (an unpaid lecturer at the University of Konigsberg in Germany). One day he was fiddling with some ideas while at home. He had his nine-year-old son with him, who was playing in the other room. Kaluza decided to be creative with the idea of applying Einstein's ideas to a "hypothetical five-dimensional universe" (Halpern, p. 5). The epiphany of the result left Kaluza ecstatic. He realized that in a five dimensional universe, not only can Einstein's theories continue to work as they do in a four dimensional universe (three dimensions of space and one dimension of time), but they would coincide with theories of electromagnetism. This discovery allowed Kaluza to begin thinking about unifying all the laws of physics. “To his son’s surprise, he froze momentarily in place, then stood up abruptly and—in his own eureka shout—began to hum a Mozart aria” (Halpern, p. 6).

Three years later and on the other side of the world, Oskar Klein, unfamiliar with Kaluza’s work, carried out the same tests Kaluza had done. Klein was teaching basic physics courses at the University of Michigan when he realized that he could examine the electromagnetic strength of particles within gravitational fields. He found that particles act like waves, not solid spheres, and that there is not only a fourth dimension, but also a fifth. Klein believed that we do not see the extra dimensions because they are rolled up tightly into very small sizes. He claimed that what we normally think of as a universe of particles existing in three dimensions of space, is actually something moving around in a circular form in a fourth dimension. Every point travels, but not only up and down, back and forth, or side to side, but also in directions that escape human senses. He concluded that humans do not see these loops because they are so small in circumference.

Klein spent years developing his fifth dimension model, only to become overwhelmed by the resistance leveled against multiple-dimension theories. Eventually several of his colleagues convinced him to abandon his studies.

Here we witness the beginnings of nature revealing itself to physicists, leading them to the revelatory conclusions they would discover, “Sometimes in discussions among physicists, when it turns out that mathematically beautiful ideas are actually relevant to the real world, we get the feeling that there is something behind the black board, some deeper truth foreshadowing a final theory that makes our ideas turn out so well" (Peat, p. 6). For the first but not the last time, the universe had elegantly manifested itself to scientists who could think beyond the three dimensional confines of Einstein-ian physics.

Misbehaving particles

Two other thinkers extended the Kaluza-Klein model. In the 1950s, the Italian physicist Tulio Regge tracks the behavior of particles as they are thrown against different kinds of surfaces. At the time, physicists assumed that particles were spheres and behaved as solid objects. Rather than bouncing off various surfaces, Regge noticed that some particles could "ring" with energy. They behaved like a bell that is struck. He realized the particles were vibrating, some even seemed to evaporate. He claimed that particles temporarily possess energy that they did not previously possess before being struck, and then the energy disappears and the particle goes back to its state before impact. It was as if parts of matter were temporarily coming into existence, and then after being present and "ringing," would immediately vanish from existence. As Regge studied these particles, he found that they were a completely different kind of substance and behave very differently than atomic, point particles. "In other words," Halpern writes, the particles "referred to spinning blobs of matter—extended objects or temporary particles that are smeared out over a finite region of space" (pp. 44-45).

In the late 1960s, Roger Penrose's work brought the ideas of what was later known as string theory closer to being an established theory. As a geometrist, Penrose argued that elementary particles are twists. They operate at the quantum level and are capable of adjusting themselves. He asserted that elementary particles are flexible and dynamic, not sphere-like and still.

These findings would aid in the emergence of string theory as its proponents struggled to overcome the confines of physics dominant paradigms. Yet the larger physics community dismissed the findings of these two physicists. Due to the mounting evidence of atomic particle theory, the larger community of physicists remained convinced that particles are solid points, not manipulate-able, changeable substances.

Gabriele Venziano and Leonard Susskind

In 1968, a young physics student named Gabriele Veneziano was looking through an old book of equations formulated by Enlightenment scientist Leonard Euler (McMaster, 2003). Where others had conjectured that particles are blotches and twists that can bend and warp as they adjust to the environment, Veneziano discovered that particles vibrate, and function more like strings, in a similar fashion of Tugge and Penrose. While his ideas sounded familiar to the work of Tugge and Penrose, Veneziano's discovery came from a different set of equations.

Veneziano was the first person to refer to these particles as "strings,"

> Veneziano proposed an *ad hoc* model. At the time it was merely a mathematical procedure without any underlying physical picture. In the course of subsequent investigation, however, it became clear that Veneziano's model was describing the quantized motion of a *string.* This constituted a remarkable departure from previous theories, which had invariably modeled matter in terms of *particles.* Yet

> at least in some respects the string model was in better agreement with experiment than the more traditional particle approaches. (Davies & Brown, pp. 67-68)

Veneziano then published an essay on the potential of matter being made of "strings." Despite a successful publication, no prominent physicist sought to further develop the findings in Veneziano's work.

The pursuit of discovering atomic point particles was developing. In other words, physicists felt they were piecing the mysteries of the universe together with findings that supported point particles as the most elementary particles of matter. The idea of strings did not fit the interests of research at the time, "In the end it became a choice between entertaining ghosts or working in a multidimensional space, and physicists, who are traditionally horrified of the metaphysical, chose the latter" (Peat, p. 48)..

Veneziano's findings further developed the work of Regge regarding the behavior of sub-atomic particles. Where Regge argued that particles could smear and ring, Veneziano discovers that particles resonate. By this, he meant that they have unique properties, according to the equations, that are not measured in current models of physics.

Yet, as physicists continued to push their mathematical formulas further and further in the pursuit of finding ways to explain the universe, they could not avoid running into the existence of extra dimensions and the mathematical conclusions that particles are not solid spheres, but warping, moving, vibrating strings.

Just as Kaluza was complemented by Klein, Veneziano had, unbeknownst to him, allies on the other side of the world. About the same time as Veneziano's discovery of string theory, English physicist P. A. M. Dirac was theorizing "mirror-image" properties of particles, which suggest the existence of particles outside of three dimensional space (p. 75).

In 1970, another young physics student, Leonard Susskind, was working with Veneziano's findings. This curious, energetic physicist illuminated Veneziano's claim that all particles, not just some, consist of strings, by offering yet another formula as evidence that particles behave like shape-shifting, warping objects. Like Veneziano, Susskind was discouraged by his experiences in the physics community when he tried to share his findings. Susskind submitted his work to a journal, only to have his ideas hastily rejected. He describes his reaction in the documentary, *The Elegant Universe*,

> I was completely convinced that when it came back they were going to say that "Susskind is the next Einstein, or maybe even the next Newton!" And it came back saying, "Nah, this paper is not very good. It probably shouldn't be published." I was truly knocked off my chair, I was depressed, I was unhappy, and I was saddened by it. It made me a nervous wreck, and the result was I went home and got drunk. (McMaster, 2003)

Susskind was left to deal with knowing his discovery would be ignored.

These two thinkers eventually developed reputations for their contributions. A pattern was beginning to emerge, no matter the path physicists walk to pursue equations about particles, they were finding that particles are more dynamic that had been conventionally thought; while at the same time other physicists were realizing the rationality of extra dimensions.

The Green-Schwarz revelation

As string theory, in its early forms, was relegated to the margins of physics, two physicists who lived on opposite sides of the Atlantic Ocean became friends. The friendship of the young physicists Michael Greene and John Schwarz was built upon their shared commitment to the obscure idea of what was by then being referred to, at least by those who were inspired by the findings of Veneziano and his predecessors, as "string theory." These two friends were connected by their common belief in the mathematical potential to prove the existence of strings as elementary particles.

Yet the idea of strings had problems. Over the years anomalies had been piling up against string theory as string theory experimenters were working on their ideas. The small group of string theory pioneers had been arguing for years that strings are part of the body of elementary particles, yet no one had given the larger community of physicists reason to pay attention. After all, new point particles were continuing to be discovered through experimentation. Perhaps the greatest challenge was that string theorists were not yet united. They had no identity, no organization. Further, they had no clearly substantive claims to argue from. What work they had done was all theoretical physics, and while interesting, its growing number of anomalies were haunting any string theorist who wished to be taken seriously in the physics community.

Further, no one had yet made the bold statement that strings are the most elementary of all particles that make up the universe. Up until the Green-Schwarz discovery, which I discuss in this section, strings had only been studied as a kind of particle, not *the* most elementary particle. It was understood that such a claim would fly in the face of what was already known about point particles. The clear evidence of quantum mechanics as an established theory contradicted string theory. The problem was that string theory proposed the existence of gravity at the quantum level, whereas quantum mechanics does not imply the presence of gravity. Unless string theorists could show that the quantum world is subject to gravity, the theory had no chance of coinciding with the well established paradigm of quantum mechanics. As physics entered the 1980s, this would change.

Yet Green and Schwarz were uncomfortable dismissing the discoveries made by Kaluza, Klein, Tugge, Regge, and Veneziano. Because of his devotion to studying multiple dimension equations and entertaining the possibility of strings, John Schwarz was denied tenure at Princeton University in 1972. He moved to a non-tenure position at Caltech and stayed there for many years, content to do so because of his devotion to the potential of string theory.

Then, one night in the summer of 1984 these two physicists were at the Aspen Center for Physics in Colorado, battling the thunder and lightning outside as they dealt with the mathematical anomalies that plagued multiple dimension formulas. As the story goes, the two scientists solved all of the problems to the equations just after a violent bolt of lightning struck. Green recalls telling Schwarz, “We must be getting close because the gods are trying to stop us from completing these calculations” (McMaster, 2003). Then the answer came,

> Schwarz scribbled the calculation on his note pad. Green worked it out on the blackboard. Green came up with 486. “Oh dear” he said in his soft London accent. “It doesn’t work.” Schwarz looked down at his pad, “Try it again,” he said. This time Green multiplied correctly, and—bingo!—he and Schwarz

> confirmed the mathematics, at least, of a theory called superstrings. (Taubes, 1986, p. 34)

With this new formula they realized that strings are not just a form of particles, but are present within all particles, essentially making the ideas of previous claims about particles as strings complete, anomaly-free. To solve the anomalies Green and Schwarz took the formulas of quantum mechanics and treated the particles not as points, but as strings. Suddenly the Green and Schwarz formulation worked. It freed string theory of the gravity and quantum mechanics contradictions,

> Twenty years ago, this chic playground for skiers and celebrities gave birth to a scientific revolution. An abstruse mathematical discovery made here sparked the explosion of "string theory," humanity's best attempt at the ultimate explanation of matter and energy, space and time. Now, 2 decades later, physicists have returned to a cloistered compound at the north end of town to mull over a nagging question: Can string theory account for what we already know about the universe? At a month-long workshop more than 50 researchers have gathered to discuss whether the theory can accommodate the data they already have and make predictions about future experiments — fundamental scientific tests that this vaunted "Theory of Everything" has yet to pass. (Cho, 2004, p. 1460)

This event is known as the “first revolution” in string theory (Taubes, 1999, p. 512). This finding put string theory on the map, and turned it into a seriously studied subject in physics,

> String theory has been the subject of thousands of papers since 1984, when it emerged as a potential Theory of Everything, and over 400 physicists have

> registered for the latest meeting in Potsdam, Germany, this month. Universities, once hesitant to hire string theorists, have been competing vigorously to get them on campus. Harvard, for example, lured Strominger away from the University of California (UC), Santa Barbara, while Stanford snatched Steve Shenker from Rutgers University, and Princeton snagged Eric and Hermann Verlinde, twins who had been tenured at separate institutions in the Netherlands. (Taubes, 1999, p. 512)

Three years after the finding Schwarz (1987) wrote, “Superstring theory is developing at a breathtaking pace as more and more clever people join in the enterprise” (p. 39). String theory had been put on the map of theoretical physics.

After Green and Schwarz publish their findings, many physicists found their evidence of string particles clear and convincing. Brian Greene’s PBS documentary shows John Schwarz’s portrait on the front pages of two newspapers with the headlines, “Scientists Pursue a Theory of Everything,” and “A Theory of Everything Takes Shape” (McMaster, 2003). In an interview, John Schwarz described his excitement at the warm reception of the theory. He was surprised that their findings were so well received, considering the earlier rejection,

> When we found the anomaly cancellation in the summer of 1984, I had already become sufficiently accustomed to the way the community was responding, so I didn’t expect anywhere near the kind of enthusiastic reaction that the work in fact got. I always expected that superstring theory would eventually become the important fashion for unification, but I expected the transition to be rather

> gradual. In fact, after the summer of '84, it was less than a year before a large number of people were working on this. (Davies & Brown, 1988, p. 88)

The findings rocked the world of physics. The anomalies that had plagued string theorists for decades were no longer an arrow in the quiver of critics who doubted the theory's ability to overcome its own mathematical difficulties. Ironically, years later Schwarz was invited back to Princeton to give a talk on his findings, "As it turned out, the significance of his ideas for the future of theoretical physics would demonstrate how mistaken they were" in denying him tenure years earlier (Halpern, p. 235).

Green and Schwarz turned into travelling academic rock stars. Their reception was thunderous as they gave talks around the country:

> Now the two were speaking weekly at a great length, even at East Coast institutions like Harvard and Princeton, where physicists previously wouldn't have deigned to come to a talk on supergravity, let alone one on superstrings, "These lectures were packed," says Green. "There were people in the corridors. At Princeton they had to transfer us to a larger lecture hall." (Taubes, p. 49)

Schwarz was eventually given tenure at Caltech. The time of the Green-Schwarz discovery was a landmark in the history of string theory. It brought widespread attention to the theory.

Four years after the Green-Schwarz discovery the first "Strings" conference was held at the University of Maryland (Strings 2010, 2009, September 10). The group continued to grow and continued to meet for week-long gatherings to discuss the progress of the theory each spring. Over the next few years the conference would be held at various locations in the United States.

Edward Witten and M-theory

If the Kaluza-Klein theory was the breakthrough for the potential of other dimensions and the Green-Schwarz discovery legitimized string theory, then Edward Witten's M-theory in 1995 is the most exciting and influential discovery since the 1984 night in Aspen. Witten is the movement's "impresario" who brought about the second string theory revolution (Taubes, 1999, p. 512). University of Michigan physicist Michael Duff (1998) calls Witten, "the guru of string theory (and according to *Life* magazine, the sixth most influential American baby boomer)" (p. 64). And Gary Taubes (1986) says that Witten "is considered so bright that his colleagues are willing to take seriously virtually anything he suggests" (p. 48). His discovery, many believe, has essentially closed the door on arguments against the theory.

Edward Witten has demonstrated the existence of eleven dimensions in his formula, which he called "M-theory" at the "Strings '95" conference. As string theory gained traction, how the theory actually works with a unified form of universal equations was not quite so clear. As a result, string theorists began to fragment into various camps. These factions separated primarily over debate about the exact number of dimensions there are in space. Some formulas said four, some five, and others seven. Witten provided the answer. In a 1995 speech, he showed that all versions of string theory actually fit together if based on an eleven dimension universe,

> In a landmark talk at the University of Southern California in 1995, Witten suddenly drew together all the work on T-duality, S-duality and string-string duality under the umbrella of M-theory in 11 dimensions. In the following

> months, literally hundreds of papers appeared on the Internet confirming that whatever M-theory may be, it certainly involves membranes [a development in string theory that there are not only multiple dimensions, but multiple universes] in an important way . . . The resulting picture has two 10-dimensional universes (each at an end of the line) connected by a space-time of 11 dimensions. Particles--and strings--exist only in the parallel universes at the ends, which can communicate with each other only via gravity. (One can speculate that all visible matter in our universe lies on one wall, whereas the "dark matter," believed to account for the invisible mass in the universe, resides in a parallel universe on the other wall.) (Duffy, 2005, p. 68)

This discovery was one of the two most significant in the string theory movement. It solidified knowledge of how the strings work and how many dimensions of space there truly are, theoretically,

> One of the biggest ones [is] Ed Witten's breakthroughs. Ed [of the Institute for Advanced Study in Princeton, N.J.] just walked up the mountain and looked down and saw the connections that nobody else saw and in that way united the five string theories that previously were thought to be completely distinct. It was all out there; he just took a different perspective, and bang, it all came together. And that's genius. (Greene, 2003)

What did Witten mean with the name M-theory? It is up for debate. In his book-length history of string theory, Halpern claims the M stands for “Mother of All Theories.” The BBC documentary, *Parallel Universes,* provides a collage of distinguished physicists trying to unravel the puzzle of what the M in M-theory stands for, “M stands for magical theory or membrane . . . physicists get dreamy eyed when they think about M-theory . . . Maybe M stands for mother, the mother of all strings, maybe its magic, maybe it’s the majesty, the majesty of a comprehensive theory of the universe . . . magical, mystery, madness” (Barrett, 2002).

In 1998, with the help of Leonard Susskind, Witten presented an even more developed version of M-theory. “The excitement over the new duality had the conference participants literally dancing in the aisles: At the conference banquet, Jeffrey Harvey of the University of Chicago led the crowd through the motions of the *macarena*” (Goss Levi, 1998, p. 22).

The new view of the theory that continually developed impressed not only the string theory community, but began to convert some previous skeptics. This is because M-theory allowed string theory to be united with another camp of physics, namely those interested in loop quantum gravity, which was the final force of nature that needed to be integrated into the theory was gravity. Even Sheldon Glasgow, perhaps the most outspoken critic of string theory, recognized the significance of these findings.

All of these developments aided the continual growth of adherents of the theory. Following the Witten discovery, the Strings conference was held for the first time outside of the United States, going to Amsterdam in 1997. In the following years the theory would continue to attract physicists as the conference was held in Germany, India, England, France, China, Spain, and Italy.

Lisa Randall and gravity

In *Parallel Universes,* the narrator asks the question “Is our universe really alone?” After a long pause, the answer comes, “It began with Lisa Randall,” as Randall is gracefully climbing a rock. The young physicist Randall is fascinated with the weakness of gravity. She has been named one of the 75 most influential people in the twenty-first century by *Esquire Magazine,* among *Time Magazine*’s 100 most influential people, and was in *Newsweek*’s “Who’s Next in 2006” and was called “one of the most promising theoretical physicists of her generation” (Randall, 2007, July 1).

After M-theory emerged, Randall realized that gravity seems to be leaking into our three dimensions from its previous position in the other dimensions. Randall hypothesizes that the other dimensions found in string theory are actually part of another universe. The gravity we are receiving are the leftovers of gravity from another universe because we are living in one of multiple parallel universes that are present in the same “place” that we reside in, but is not made of the same particles as our universe. Randall’s ideas are based on the assumption that gravity flows between the varying universes. In other words, this other universe, or universes, is invisible to us, even though they are, in their position of how we understand space, right here with us. They are what scientist turned journalist Mitchell Waldrop (1985) hypothesized before Randall’s work, “There could easily be shadow galaxies, shadow stars, shadow planets, and shadow people, all occupying the same space we do, intermingling with all the stars and planets of our own universe, and yet totally undetectable to us except by their gravitational effects” (p. 1253).

This idea of multiple universes exploded in the world of physics as Randall proved mathematically that this hypothesis works. Soon, more and more physicists began working with the equations of eleven dimensions, and not just extra dimensions, but extra universes. *Discover*'s October 2005 cover story addresses these new elements of string theory that "speculate that our three-dimensional universe is part of a much larger, higher-dimensional realty and that the Big Bang is the result of a collision between our three-dimensional universe and another like it" (Mlodinow, p. 64).These ideas have gone even further. Currently, physicists are flirting with the catastrophic consequences if these parallel universes were to collide. They argue that such an event was what transpired in "the big bang," when our universe was born.

The big picture

I began this chapter with the old story of multiple dimensions being shunned by the scientific world as mysticism. Over the years, the scientific reception of multiple dimensions has changed. Some notions about the makeup of the universe that were once relegated to the irrational world of mysticism have now become part of the most complex programs of physics research.

Popular writings and films bring the hidden parts of the universe into view. Our understanding of the universe is drastically changed. This is the story of how an emerging scientific movement is succeeding. More physics students become interested in it, and the theory continues to be shared with vernacular audiences.

String theorists are now pondering the possibilities of multiple universes possessing life. In some ways it is as if string theory has come full circle from that time when Zollner insisted that an extra dimension exists. Early physicists and mystics, not necessarily working together, claimed the existence of multiple dimensions as proof of God, of spirits. The possibility of a fourth and a fifth, even up to an eleventh dimension, lends itself to a public discourse that can entertain these possibilities.

String theory ideas were vigorously resisted by the larger physics community that was determined to escape from the unfounded assumptions of faith in the paranormal. As theorists have pursued the equations of multiple dimensions, the same old questions are resurfacing.

The theories and their implications of multiple universes are now being shared with the common reader in an elegant form that appeals to the belief systems of contemporary culture. The capacity to tap into an audience's belief in life beyond earthly experience, combined with mathematical reasoning and also the fascinating public dissemination of string theory, perhaps means that it is only a matter of time before string theory becomes the dominant form for understanding the universe, not only in the world of science, but in the popular imagination. Indeed, our view of the universe is about to change . . . or shall I say our view of the *universes*?

Edward Witten continues to work on the theory because he shares the vision that his colleagues do. They realize that with continual findings the work of physics is going to continually move in the direction of string theory. In an interview Witten asserts that it "will dominate the next half century just as quantum field theory has dominated the previous century . . ." and reminds us that physics has historically played a large role in the development of mathematics (BMS, 1985, p. 20). "We are now entering a similar episode," he suggests (p. 20). Superstring theory, having already pointed out extraordinary connections between previously unrelated branches of mathematics, will, he predicts, "exert a profound and far-reaching influence on the future of mathematics" (p. 20). With such influential power, we must not neglect the rhetorical significance of such a movement.

Coming full circle

Many of the string theorists who struggled to find success and recognition from their colleagues have, in the last couple of decades, become famous. Decades after his discovery was ignored, Veneziano has become one of the key experimentalists working on the theory at the CERN laboratory. Veneziano becomes a key figure in the history of string theory because of what he "accidentally discovered." F. David Peat (1988) concludes his *Superstrings and the Search for the Theory of Everything*, by referring to that moment when "Veneziano's attempt to make sense of experimental data" led to "the string revolution" (p. 338). And Susskind's importance is demonstrated by The Edge organization, a forum for intellectual giants to share their ideas with the world, which refers to Susskind as "the discoverer of string theory" (Brockman, 2003).

Michael Green and John Schwarz are still recognized and celebrated for their discovery of string theory as the most elementary of particles. Their close friend Edward Witten continues to enjoy his M-theory being unchallenged, at least on a theoretical level, by any other theoretical physicist.

Strains of resistance

While finding success and prominence, string theory is still based solely on mathematical philosophy. It is not based on experimental data. As a result, it is still heavily scrutinized by critics. While the mathematical philosophy of the theory is grounded, empirical data is still yet to be discovered. Quantum theorists and proponents of general relativity often minimize string theory to nothing more than mathematical meddling that attempts to support notions of theology and mysticism.

Following the Green-Schwarz discovery came the “20 Years’ War” when “string theorists’ sweeping claims raised other physicists’ hackles” (Musser, 2008, p. 278). Along with that prominence came more questions and yet without the experimental evidence came doubt. Two prominent critics of string theory, Paul Ginsparg and Sheldon Glashow, wrote in an opinion column two years after the Green-Schwarz discovery that their field would spiral downward into the unfounded argumentative notions of ancient forms of education. In a BBC interview in 1987, Richard Feynman said the theory is crazy, claiming that string theorists do not check their own ideas, and that their lack of experimentation is a risky business (Musser, 2008).

With Witten’s discovery of M-theory, Sheldon Glashow expressed his disdain for a theory which continues to be pursued yet not proven experimentally. Glashow shared a poem he wrote and presented at a conference that was meant to upend the efforts of string theorists, namely the infamous Witten,

The Theory of Everything, if you dare to be bold,
Might be something more than a string orbifold.
While some of your leaders have got old and sclerotic,
Not to be trusted alone with things heterotic,

Please heed our advice that you too are not smitten—

The Book is not finished, the last word is not Witten. (Halpern, p. 256)

Particle physicists have written books critical of string theory. Some of the books which work to debunk the theory come with titles such as *The End of Physics: the Myth of a Unified Theory* (Lindley, 1994) and *The End of Science* (Horgan, 1998).

The result is a contemporary battle at the public level between proponents of the theory, who are mesmerizing readers with the mind-boggling claims, and critics of the theory who continue to point out the theory's lack of evidence. Yet literature designed to celebrate the claims of string theory is more readily published. Still, string theorists are working diligently to find ways to offer experimental evidence in support of their claims.

Conclusion

Combined with the argumentative structure of the string theory movement, which I discuss in the next chapters, this story prepares audiences to see strings and extra dimensions as mysteries of nature which are naturally unrolling before our eyes. The string theory history contextualizes the arguments made for unification and the Theory of Everything. The history itself functions as an argument for the theory. Yet this vision about finding unification is not new to science. Within the world of physics, the dream of unification has a rich history that has inspired scientists and philosophers for centuries. University of Maryland physicist S. James Gates Jr. begins his 2006 *Physics Today* article on the topic with the sentence, "String theory has a strange and remarkable history in which the conventional wisdom of the field has sometimes changed chaotically" (p. 54).

At the forefront of the string theory story are assumptions of nature being so mysterious and complex that its readers are left waiting for more information that will mesmerize their minds around this strange new theory which, as the story goes, continues to emerge one way or another. In his own vernacular work on the topic, physicist Paul Halpern (2004) asks near the end of his history of string theory, “Suppose higher dimensions prove essential for describing all aspects of physics with a simple set of principles. How would this momentous discovery change our culture?” (p. 292). With the use of its rhetorical resources, this new theory is changing our common understanding of the universe.

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Chapter 2

Invention, Translation, and Vernacular Science

Rhetorical criticism as method allows me to cluster the common rhetorical themes in the popularizing discourses of a contemporary scientific movement. I write this dissertation as an analyst, with the intent of drawing conclusions about forms of public discourse. I work to discover the process of rhetorical invention in the string theory movement.

As a rhetorical critic I am interested in understanding how science works. Science, perhaps more than any other form of thought, masks and denies its use of rhetoric. Yet language is and must be employed in scientific presentation, especially to the public. I see scientific rhetoric as a most challenging riddle for the intellectual mind to try to unravel. For me, this process is one that is personally motivating and intellectually challenging.

When scientists transfer claims from the technical realm to the public sphere, technical vocabulary has to be translated into non-technical terminology. This is a particular challenge in the scientific community as scientists must engage in the process of rhetorical invention when they bring their ideas to vernacular audiences. That is, they must formulate the words they will use as they put their ideas into language that appeals to popular understanding. Even more challenging, abstract mathematical formulations have to be expressed as concrete images that audiences will understand.

In this chapter I lay out the framework which allows popular scientific terms to be accepted, and which allows me to examine rhetorical strategies employed by string theorists in subsequent chapters. I perform this analysis in increments, starting with the assumption that scientific rhetorical invention is about the use of metaphors. By moving from the challenge of rhetorical invention of technical to vernacular knowledge, to the translation of scientific ideas into sacred form, and the employment of Aristotelian rhetoric in public discourse, I explain how scientific argumentation operates at the public level; therefore setting up the theoretical foundation of my analysis of popular string theory rhetoric. Here I discuss rhetorical invention as the creation and employment of powerful scientific terms. I treat *invention as the discovery of cultural values that facilitates the acceptance of scientific argument*.

I begin this chapter by first describing translation as the process of scientific rhetorical invention. To examine that translation, I then contextualize the situation where this process transpires: the public realm, or a public science. The strategies by which public science takes form are in the *logos* of metaphor, the *ethos* of heroic scientific tales, and the *pathos* of the wonderment of science. I conclude with an overview of a theme I must draw upon in my study, the ageless struggle of technical ideas wanting to be free of rhetorical persuasion in the eyes of proponents of science; for this study is situated amidst of this ageless battle of rhetorical invention.

Methodologically, I operate under several principles that constitute the function of public science. My map for navigating the philosophy of public science follows a deductive process of theorizing. I begin broadly by discussing rhetorical invention. I then situate popular scientific rhetoric, and more specifically string theory discourse, into this model of invention. Yet invention is connected to translation when popularized. Translation is a process of rhetorical invention. I conclude by contextualizing this discussion by turning to two conflicting, yet simultaneously co-existing traditions of rhetorical understanding.

In this chapter I explain the ways scientists construct their arguments in order to appeal to public audiences, while giving particular attention to the translation of mythic notions in the creating of a public science as a central process of scientific invention. A key component of the invention process is translation—the means by which rhetors draw upon past ideas and reshape them in order to support their claims. As invention is the process of discovering the arguments to be made, translation is the inevitable activity of drawing upon ideas in order to make invention possible. That is, while invention deals with ideas that the rhetor wants to express, translation, as part of the invention process, is the transferring of complex ideas into vernacular expression.

Structure of scientific invention

This brings me to a structure of assumptions, by which public science is founded. It is the interworking of these assumptions that make up scientific rhetorical invention. First, we must understand how scientific invention is based on understanding audience values and knowing where scientists turn to in efforts to achieve persuasion; or in other words, what equipment for argumentation will be available. Second, translation is the process scientists will reconstruct scientific ideas to fit within an audience's value systems. Third, string theory advocates appeal to themes of sacredness, celebration of scientists as heroes, and the reference of key rhetorical strategies that are omnipresent throughout the movement's discourses and allow string theory to be understood as the great unifying theory of physics. Finally, the romantic tale leads to a blissful, millennial destination in which a grand theory operates in the lives of scientists and their audiences as a new, sacred state. It is with these critical presuppositions that I closely examine the popularization of string theory.

To grasp invention we explore the intricacies of Aristotelian artistic proofs, which are all connected. Employment of *logos* and metaphors establish a discourse of sacredness. Branching from metaphors that take on authoritative form, a sacred *ethos* of heroism emerges. And as heroes do their work, we enter into a *pathos* of beauty and wonder, which creates a mood of millennial peace of completion.

Addressing the process of rhetorical invention is critical in understanding the popularization of string theory. String theory proponents move their claims from technical mathematics and terminology into abstract vernacular discourse that permits popular understandings and acceptance of the theory as the final unifying theory. To explain this process I pay particular attention to how the abstract dream of unification and the materiality of complex theory are in tension. My interest is in revealing the cultural materials that are used to explain elite science to lay audiences.

In philosophical understandings of humanity's place in the universe, this tension is ancient. At the end of this chapter, I discuss how the battle that can be traced back to the theoretical foundations of Platonic and Aristotelian philosophy. By pursuing a Platonic dream that is ironically engaged in an Aristotelian process of employing available means of persuasion, science writers engage in constructing for us a string theory discourse that survives through abstraction. Their themes and efforts are reflective of narratives that are similarly employed in science fiction. Successful persuasion comes as rhetoric thrives in abstraction.

Inevitability of public science

Rhetorical invention is the internal transformative process that takes place as science travels from vernacular pastures as it becomes a public science. Public science is framed into taking on challenging situations, usually at the time of paradigm shifts in science. The way the situation is characterized dictates the appropriate rhetorical response. Popular string-theory discourses are organized around specific depictions of problems in physics. The nature of string-theory discourses is understandable as responses to these depictions.

Yet as we become more specific in a study of public science, we must now look at the rhetorical methods employed in public science. It remains Aristotelian because of the strong presence of artistic proofs. First, public science is grounded in appeals to *logos*, with strong employment of metaphor. That appeal to *logos* takes on strains of sacredness. As sacredness enters the mood of the discussion strains of *ethos* and the framing of heroes takes place. As we progress through the salvation via heroes, appeals to *pathos* via wonderment and beauty enter into the discourse. Mythological elements come via being transferred from value system to value system via multiple value systems sharing common languages.

Transference of ideas to the public is an essential area of work for rhetorical scholars. In the string theory movement, for example, we are given a new universe, which emerges from a mathematical concept that is transferred into everyday language for us to examine, and it then becomes reality for us. This is a common rhetorical/literary technique, as in the words of an accomplished science fiction scholar, “it is not uncommon for the story to begin under the umbrella of a mathematical/contemplative sublime idea" (Csicsery-Ronay, Jr., 2008, p. 162). Writers of science cannot appease that "cultural milieu" without being particular in their choice of how to argue, what to argue, and, more importantly, knowing what is in the minds of such expansive audiences. Public science is so prevalent that it is somewhat of an intellectual institution.

There is a market for public science literature. The study and practice of persuasion in science is a craft that is developing into a discipline at the university level. For example, the Massachusetts Institute of Technology offers a Masters degree in science writing. With a growing market for science literature, the study and practice of the craft of science writing is becoming an important part of a scientific establishment that wishes to popularize its work. The result is that scientific ideas are presented in artistic ways. Public culture is developing an appetite for science in journalistic form. As a consequence, we have developed rhetorical theories of public science.

In chapter 1, I state that the popularization of string theory is a movement. Historians and philosophers of science have certainly looked at scientific breakthroughs and the changes that take place in scientific thought as movements. Breakthroughs are understood as important events in history and writers of science treat them as shifts that are the result of significant acts performed by significant people. What is missing from this body of scholarship is the significance of rhetoric in shaping common, non-scientific perceptions in order to accomplish a more holistic alteration of thought. The process of rhetorical invention in string theory discourse tells us something novel about science communication: in the absence of empirical evidence comes the employment of sacred modes of argument, through which invented understandings of scientific discovery are made accessible to the public.

I am discussing the challenge of scientific invention and doing so with a foundation of Aristotelian understandings of persuasion. Yet Aristotle did not give us a terminology to work through in understanding mass perceptions of technical knowledge. Such a jump from technicality to vernacular is a challenge. It could even be framed as a burden. And still, rhetoric is employed in order to solve problems. Indeed, it comes with rhetors having motives. Motive is the attempt to transcend problems. A contemporary rhetorical theorist called this challenge the rhetorical exigency.

In public science, new theories are presented to the public as a means for addressing exigencies. Lloyd Bitzer's (1968) work is a treatment of rhetoric as a tool for changing situational exigencies. The exigency is magnified for the audience so that it feels the need for a solution. Then, particular terminologies (such as metaphors and ideographs) are assigned as the means to providing solutions to the exigencies. Finally, the beauty of persuasion comes through the careful articulation of the rhetoric's capacity to solve the exigency (Bitzer, 1968).

Bitzer (1968) argues that every rhetorical situation is a rhetorical situation because exigencies exist, "Any *exigency* is an imperfection marked by urgency, it is a defect, an obstacle, something waiting to be done, a thing which is other than it should be" (p. 6). Exigencies need to be solved. Richard Vatz (1969) responds to Bitzer, stating that rhetoric not only answers exigencies, but constructs the situations in which problems need to be resolved. Speakers recognize problems and seek out solutions. Proscribing those solutions, rhetoric becomes the means by which exigencies are overcome, "An exigency is rhetorical when it is capable of positive modification and when positive modification requires discourse or can be assisted by discourse" (p. 7). The work of addressing the exigency of this cognitive chasm is to build the bridge from scientific thought to audience perspectives.

Scientists work to address exigencies at various levels of science. To contextualize the type of scientific discourse I analyze in subsequent chapters, I need to briefly outline the three types of scientific discourse. The first, which is not in the realm of this study, is scientist-to-scientist rhetoric. While rhetoric exists in the lab, I'm focusing on the scientist-to-public interface. Here rhetoric is understood as the language of specialization. The second is when the scientists themselves address the public. Here translation of specialization does take place. In the third type science proponents serve as the mediator between scientist and audience. The two latter forms are both explored in this study. Both address the public, whether the scientist or the science journalist.

In all the public coverage science receives, new scientific ideas are usually framed as solutions to problems. That is, science can achieve public status by heightening the exigency that scientists believe they can resolve. Part of the challenge for string theory is justifying to audiences the existing exigency. To address this "exigency" of science, as Prelli calls it, "This means picking out the crucial points for decision, expressing them so they secure needed attention, and rendering scientifically reasonable the decisions proposed to the community" (p. 184).

As the public engages scientific ideas, their level of acceptance will depend on how easily ideas connect to the audience's political and ideological assumptions. If the audience members are intrigued by the idea, they will invite further discussion. Through their acceptance of the ideas they hear, the scientific ideas that they see as desirable, "the successful transposition of technical and strategic recommendations into practice is, according to the pragmatist model, increasingly dependent on mediation by the public as a political institution" (Habermas, 1970, p. 68). In other words, although orators control the pulpit, audiences control the worth of ideas that are presented to them. Transference of scientific ideas into vernacular discourse cannot happen without the aid of the audience allowing it to work for them. That is, continual persuasion of vernacular audiences will progress on a given topic without the support of the audience who encourages it to continue to be given to them, "Such communication must therefore necessarily be rooted in social interests and in the value-orientations of a given social life-world" (Perelman & Olbrechts-Tyteca, p. 68).

As science plays an ever more significant role in the public sphere as a method for resolving cultural problems and divisions, rhetorical scholars have a mandate to study public science. We are able to witness the continual reinvention of technical ideas in order to be publicized.

The importance of rhetoric is found in unearthing the significance of what is taken for granted. Technical ideas are not intrinsically significant for the public; they must be demonstrated through argumentation that is connected to some set of empirical or philosophical observations. This strategy is the art and craft of the science writer who publicizes scientific ideas in a format those appeals to non-scientific readers.

Metaphor

As the term “string” portends, the concepts of theoretical physics are translated with metaphors. In the present state of the science, there are only mathematical but not yet empirical claims for the viability of this theory. Moreover, string theory claims to offer an ultimate theory – theoretical unification or “A theory of everything.” Such abstraction requires a rich array of metaphorical phrases to offer an understandable picture of the new reality being described. Not surprisingly, these metaphors are drawn from the most readily available storehouse of transcendent tropes – the sacred language of religion. Not unlike science fiction, popular explanations of science rely on the language for God.

In scientific rhetorical invention, the first step is finding words that will appeal to a public; a capsule that will carry the scientific ideas into accessible language. Therefore, *logos* and comparisons to vernacular language become templates for scientists. Metaphor is an important element in bringing complex ideas to the public. Telling great stories allow the metaphors to carry the power of persuasion. Finding the right metaphor is the act of creating an enthymeme, “The most fundamental values in a culture will be coherent with the metaphorical structure of the most fundamental concepts in the culture” (Lakoff & Johnson, 1980, p. 22). The capacity to draw upon larger, fundamental cultural concepts will enable the audience to accept new ideas.

Metaphors are a significant form of persuasion for science. They take on forms of genre that are rich with sacred mythos. As a result, scientific discourse takes on forms of discourse that promise salvation. Metaphor is like a sped-up analogy, it is quick, and therefore hard to trace because its history is difficult to uncover, “Any analogy—unless, like allegory or parable, it is confined within a rigid form—turns into metaphor quite spontaneously. It is the very absence of fusion in an allegory or a parable that compels us to regard them as conventional forms which, by tradition, systematically decline to make a fusion" (Perelman & Olbrechts-Tyteca, p. 403). Hence, science seems so original, so novel not only in its ideas, but in its language. The most effective metaphors in science do not appear as metaphors at all. They are slowly created and distributed. And operating in abstraction, they do not really offer grounds for opposition. Part of the reason for the transparency of scientific metaphor also is attributable to the way these metaphors are carefully crafted, broadly expressed, and reverenced by scientists themselves. Burke's (1954) treatment of scientific metaphor demonstrates that "the scientific analogy is more patiently pursued, being employed to inform an entire work or movement" (p. 96). Burke argues that scientific metaphors find their power in abstraction, "when we describe in abstract terms we are not sticking to facts at all, we are substituting something else" (p. 95).

Rhetors must find common ground with audiences; otherwise metaphors will not succeed. New rhetorics draw upon the enthymemes of previous rhetorics. Through telling compelling stories of heroes and wonderment via translating notions of the sacred into the scientific, we find the grounds upon which metaphors can work their magic.

The popularized, linguistic form of the idea, the metaphor, becomes an appeal to an audience's sense of logic. *Logos* is also used. In the employment of *logos*, science writers engage in logical arguments through enthymematic language. The use of scientific metaphor that is shrouded in sacredness allows proponents to appeal to readers of public scientific discourse. Metaphor allows the scientist to have something to attach their arguments to. The process goes even further. By establishing a metaphor that audience can relate to, the scientist is establishing footing on which the audience will follow the trail of reasoning by which the scientist wishes the audience to follow.

Like any effort to persuade, scientists must employ rhetorical strategies in order to obtain audience support. Scientific movements have much to do with the debate that goes on between established paradigms and new theories that challenge the status quo. The more appealing the rhetoric of the new idea in its metaphoric creativity, the more provocative it is for the reader. In the following chapters I discuss metaphors, which carry heavy rhetorical clout in the string theory movement. The underlying challenge in getting readers to accept scientific claims and to see the universe in a new way lies in the ability of scientists to employ metaphors and themes of argument that audiences have already come to accept. In other words, they must affect or change nature by borrowing from the culture's forms of argument. Scientists determine what constitutes reality for the rest of the world.

Translation from scientific language to vernacular understandings is aided with the ends of the move being the value system of the audience. In this instance, scientific language enters into the mindset of sacred beliefs and therefore sacred terminology that is available and most useful.

Logos, translation, and the sacred as rhetorical resource

Translation is the expression of ideas in new forms. In the context of this project, it is the translation of notions of the sacred into the scientific, and certainly the scientific being transformed into the sacred. The capacity for these specialized discourses to represent knowledge for the general public lies in the resources available. As invention is the process of discovering resources, translation is a key element of the process of transferring them, which means translation is the process of using older, mythic vernacular notions that make arguments capable of being understood and appreciated by public audiences. Here I speak of science being framed in the cloth of sacred types of knowledge. Scientific translation is moving from the technical to the vernacular, with the vernacular being prone to language of the sacred.

Translation is not a perfect mirroring of discourse taken from one rhetorical realm to another. There are roadblocks in the transmission of ideas from one site to another, or from a complex, specialized form of discourse to a simpler, vernacular one. Translation means a discourse must be forced into a different realm.

Translation is the rhetorical negotiation as ideas move from one field to another. Translation is imperfect. Ideas are not only incomplete as they move into other discourses, but they are altered. They can take on different meanings in the new discourses, and can come to have different implications for new audiences. Nonetheless, here we discuss the removal of baggage that is associated with discourse of the sacred for the sake of attempting secular form. Yet here we focus on the demise of the sacred when it is transferred into public science expression.

In his discussion of religion and the nature of rhetoric, Burke (1970) provides insight. In *The Rhetoric of Religion,* Burke writes that the types of argumentation that escape or rather cannot be associated with the material world are attempts to employ absolutist language that is unquestionable. This type of language is meant to describe the natural world in an encompassing narrative, in which the transcendent reality gives humanity a sense of purpose. In other words, it is an effort to describe the supernatural.

Burke lists four kinds of words: those that describe nature, those that describe socio-political matters, those that describe words, and those that describe the supernatural. The first three have their own sets of terms where the symbol can be connected to the object without the need for logical argument. In these instances there is the potential for empirical verification based upon observation.

The fourth set of terms used to describe the supernatural must borrow from the words of the other three types. Burke refers to such linguistic borrowing as "ineffable" because the rhetor's claims are "borrowed from our words for the sorts of things we can talk about literally, our words for the three empirical orders (the world of everyday experience)" (p. 15). At the level of public to vernacular science, we operate, in the Burkean model, in the fourth realm of term creation and usage. Burke uses examples of "God's powerful (a physical analogy)" or "God as the Word (a linguistic analogy)" (p. 15).

The use of metaphor in creating arguments that work for an audience comes because the prescribed scientific idea, shrouded in the language of the sacred, offers transcendence over the issues that scientists grapple with in their research. The societal exigencies audiences grapple with. Therefore, popularized scientific ideas address the concerns of multiple parties,

> There is a sense in which the word 'transcends' the thing it names. True, there is also a sense in which the word itself is material, a 'body,' a meaning 'incarnate.' For there is the dimension of sheer physicality (sheer 'motion') by which a word is uttered, transmitted, heard, read, etc. or there is the sheer physicality of the

> emotions of the brain when the brain is in any way using words, ‘thinking.’ (p. 16)

Here Burke is speaking of the way that language becomes authoritative for audiences who are not integrated into specialized scientific research. The result is that the language itself takes on an authoritative function for audiences. In other words, the inception of having a new scientific idea being shared with an audience is the only understanding of the scientific idea. The audience upon learning from the scientific idea therefore accepts the idea.

The result is the capacity to transcend the challenge of lacking wholeness in argumentation. With transcendence comes the daunting challenge of the lack of empiricism. Execution is demonstrated through language usage. The movement to do so is accomplished by the employment of terms that are authoritative enough to dismiss the need for empiricism. They take the form of religious terminologies. Burke demonstrates how St. Augustine, the first practitioner in rhetorical history to adopt Greek and Roman rhetorical theories as methods for religious persuasion, was able to use a “Biblical terminology of motives” that “enabled him to ‘transcend’ the sheerly empirical events of his times” (p. 58).

The rhetoric of science is connected to the power of language as the primary means by which humanity seeks transcendence:

> Biologically, humanity can never fully escape the natural world that prescribes the boundaries of animal experience, but the capacity to symbolize enables humans to transcend purely materialistic nature. Humans enter a unique and complex experiential dimension through possessing the capacity to symbolize. Once we

> can *name* things and experiences, the universe takes on new qualities and new significances. (Prelli, p. 15)

Translation is the process by which metaphors are employed in the transference of scientific ideas into language that appeals to common readers of science.

Here I have addressed the ways in which scientists engage in translation of the sacred into the scientific, and which, as I show in the analysis chapters, happens most powerfully via metaphor. Now I move on to the ways in which this translation is executed: creating heroes and offering excitement and wonder. Yet metaphor opens the door for narratives to be told by popular science proponents.

Genre and the employment of ethos in scientific narrative

Narratives have characters. Heroes and villains provide dramatic effect as well as demonstrating reference to heroes' causes. Science is told as a story of discovery. It is a quest story with heroes and villains. This adventure story draws on the mythos of romance. It is the pursuit of the Holy Grail. This genre shapes the audience's reception of the characters, their motives, and their virtues. *Logos* via audience-accessible wording allows scientists to have an understandable voice with the public; the metaphors open the door for stories to be told. In essence, metaphor opens up the opportunity for scientists to establish *ethos*. Popular stories of scientific discoveries function to create a new reality. Ultimately, the ideas of science are translated into adventure narratives with the skillful creation of heroes and expressions of excitement and wonder. These stories present key rhetorical terms to readers. These terms carry heavy rhetorical power and help to shape reality. The same elements of genre are found in science-fiction writing. Nonetheless, genre permeates the language of science whether describing the fictional or the experimental. This is not to conflate the fictional with serious scientific research, but to realize that the two borrow from the same forms of expression. These genres have to do with particular kinds of stories and particular types of terms that come to possess special meaning. These emerge in themes presented to audiences of science, such as the respect scientist's show for the idea of unification.

An important element in the publicizing of science is telling the history of regular scientists taking on the mantle of becoming heroes. This is a method of establishing *ethos* for string theorists, in which audiences are told to listen to and heed the arguments of scientists based on their credibility,

> [There is persuasion] through character whenever the speech is spoken in such a way as to make the speaker worthy of credence; for we believe fair-minded people to a greater extend and more quickly [than we do others] on all subjects in general and completely so in cases where there is not exact knowledge but room for doubt. And this should result from the speech, not from a previous opinion that the speaker is a certain kind of person; for it is not the cases some of the technical writers propose in their treatment of the art, that fair-mindedness on the part of the speaker makes no contribution to persuasiveness; rather, character is almost, so to speak, the controlling factor in persuasion. (Aristotle, p. 38)

One strategy of scientific discourse is praising and even mystifying the scientist who discovers the idea(s), "Good writers give readers a picture of scientists carrying out experiments, recording cause-and-effect relations, documenting observations, disturbing steady states, and being excited and sometimes startled by their findings" (Blum, et al., 2006, p. 30). This strategy is observable in the history I discuss in chapter 1 as physicists continually had to conclude, to their own surprise, that the universe is made of strings. Accomplished science writer Elise Hancock (2003) calls this strategy “track[ing] the excitement of scientists” and “uncover[ing] a detective story” (pp. 36-37). The successful use of these strategies is what enables the rhetorical terms, invented and then translated, to present a new universe.

And whenever heroes emerge, so do their enemies. Opponents always show up in the story and make the journey to victory. Support from the non-scientific community allows the proponents of a new idea to quiet enemies within their fields who disagree with the proposed theory. So that which constrains argument within the paradigm can empower, give authority to, give free reigns elsewhere. “In such cases,” Willard (1995) argues, “the expert uses paradigms as strategies rather than constraints, and becomes as much a rhetorician as a technician. In contrast with the structural account, we call this the ‘rhetorical’ account of expertise” (p. 134).

While journalists do the same work with scientific knowledge, there is always reference given to the actual experts, whether the experts are writing the popular science work or not. For it is they who have the *ethos* needed to help audiences make a transition in what they have previously assumed about the reality of the universe. Experts and key researchers are often eager to address vernacular audiences.

The scientific pathos of wonder and beauty

The final rhetorical strategy in public science is in the ornamentation of the hero story. Beauty and peaceful bliss permeate the language and heroism of vernacular science by creating wonder and excitement. The new idea is treated as a sacred mystery, which we must, as a moral obligation, seek to understand. Appealing to the emotional responses of readers is, like *ethos* in the creation of science heroes, an Aristotelian notion. *Pathos* creates emotional responses that can bring about persuasion,

> [There is persuasion] through the hearers when they are led to feel emotion by the speech; for we do not give the same judgment when grieved and rejoicing or when being friendly and hostile. To this and only this we said contemporary technical writers try to give their attention . . . The emotions are those things through which, by undergoing change, people come to differ in their judgments and which are accompanied by pain and pleasure, for example, anger pity, fear, and other such things and their opposites. (Aristotle, pp. 38, 121)

There are themes of scientific progress throughout various genres of science writing. One of those is the sacred. Sacred and religious themes within science fiction discourse have been present from the beginning of the genre (Kreuziger, 1986). Here I draw heavily upon science fiction literary studies because of its connections, from the perspective of this project, to non-fiction, popular science. Both forms of writing succeed in telling the great story. And the great story is told with the bells and whistles of wonder and excitement. Such is an appeal to *pathos*. One such pathetic appeal is to the idea of progress. Humanity desires in its pursuit of understanding the universe.

The potential to enter into fictional scientific discourse is congruent with that which is spoken of in science as real, or as experimental, philosophical, and empirical. There are various functions of the sacred that are transferred into discussions of science. These include how strains of sacredness are "fundamentalizing" in science fiction. The way we understand reality is founded with fundamental themes that are always present in stories, giving them a form of sacredness (Frisch & Matos, 1985, p. 13). These themes will also be "ultimatizing," or providing closure on the mysteries of the unknown. As humanity continues on its journey, it comes to discover the mysteries of the unknown (p. 16). Science fiction has a "moralizing" effect. As a result, the claims of scientific discovery, in relation to the fundamentalizing theme, take on a tone of sacredness (p. 20).

Yet much of that rhetorical process which follows the scientific invention of ideas has to do with the available means of persuasion as the claims move beyond logical and mathematical argument and into that which is appealing, artistic. In other words, it becomes the capacity to create something "sublime" for readers (p. 146). Here we speak of translating religious language and terminology into the creating of a sacred scientific. Csiscery-Ronay, Jr. (2008) writes that in science fiction our experience becomes more provocative, more enchanted,

> Readers of [science fiction] expect it to provide an intense experience of being translated from the mundane to imaginary worlds and ideas that exceed the familiar and the habitual. They expect to feel as if they are witnessing phenomena beyond normal limits of perception and thought that people have not been able to witness before, or perhaps even to imagine. This sense of liberation from the mundane has an established pedigree in art, in two related ways of feeling and expression: the sublime and the grotesque. (p. 146)

The sublime, which is experienced in science fiction literature and in scientific discourse in general, leads audiences to an experience of the real. Because the expert knows more than the lay audience about what they describe, readers and listeners are given a new perspective on the universe,

> In a sense, the [science fiction] sublime has become a ‘realistic’ discourse. It reflects a social world that has been saturated with technosublime narrative/image systems that adopt the language sf itself has cultivated. Advertising and media, political propaganda, and the justifications of grand public works and experiments use the emotional charge of awe and reconsolidation in technoscience to create assent and to prevent dissent, reveling in the ecstasy of control, apply the poetics of fiction to the construction of society. (Csiscery-Ronay, Jr., p. 161)

A final strategy of ornamentation of public science involves making sure the reader understands the real life implications of the proposed theory, “Explaining the general, broader, significance of a discovery is also crucial” (Blum, et al, p. 31). This is the most challenging, yet most significant more for writers of science: they are to connect what they are applying to other parts of life, to spell out the details of how the discovery changes the daily life and understanding of the reader,

> A thoughtful writer will dig into his or her interests, strengths, biases, and agendas and not only develop the story itself but also tie it to other things in the world—in science and also in the broader literature and culture—that add interest and insight to the story. The writer who attends closely to both deep and broad issues is the one who will create something that is different from what other writers are producing. This writer will write the story that is worth the readers’ time. (Blum, et al., p. 31).

Hancock calls this strategy, “Seek the grand simplicity” (p. 36). The simpler and more straightforward the finding, the more appreciation and excitement it will generate in the non-scientific community. The result is a more progressive movement for scientists as they face their biggest challenge: convincing the public that they are correct in their claims.

Employing strategies of *logos*, pathos and *ethos* in the translation of sacred notions of scientific discourse opens up the potential for persuasion. These methods allow the universe to be understood in ways that promote the metaphors which function to create the new, prescribed universe. Heroes and excitement allow metaphors to then do their work of persuasion. All these strategies perform a function which persuades audiences because they tap audience enthymemes.

Enthymeme

As scientists deal with exigencies and seek to explain their answers to mass audiences by using Aristotelian proofs, they are faced with a second task: figuring out how to appeal to their audience. The irony is in wanting to be free of rhetoric in describing a larger reality. In the addressing of vernacular audiences it is impossible to not engage in artistic proofs that tap into audience enthymemes. The bottom line is that scientists achieve their ambitions through language. They have to do it both within and outside of science. Ideas are much more likely to succeed when large audiences have been persuaded to support the idea (Brown, 2003).

In order to be able to create successful public discourses of science, rhetors must be aware of the particular challenges before them. The most difficult challenge is in making sure their arguments and findings in the world of science do not clash with audience assumptions and beliefs. All of this is to say that popular scientific discourse – not unlike its civic brethren – is enthymematic. It draws on the audience's storehouse of accepted cultural materials. It explains the unfamiliar in terms of the familiar. In doing this, it shapes the very meaning of science, scientific discovery, scientists, and scientific truth. As Einstein's theory of relativity, resonated far beyond physics to alter the way people have come to understand and connect with the world, so, too, the inventional choices that shape string-theory discourse are the lenses through which we will come to view the world.

Audiences have particular systems of thought which they subscribe to, such as religion, and which guide their lifestyles and beliefs. Successful science will coincide, or at least be shaped to coincide, with these cultural notions which audiences believe in. When scientific claims do not coincide with popular assumptions, these audience value systems can become exigencies as theorists work to get their claims widely accepted. In the end science writers have to know how to overcome the challenge of audience beliefs. In addressing how this work is done, I draw upon Aristotle.

Scientists are presented with the challenge of transcending the confines of their specialized language in the process of bringing their ideas to audiences who will accept new scientific ideas and celebrate them. In doing this, string theorists draw upon "enthymemes" that are present in the minds of audiences, as Aristotle (1991) called them. Aristotle writes about the parts of enthymemes. They are "premises specific to each species of genus [of knowledge]" and are "common to all" (p. 47). This means that enthymemes are thoughts that are unique to a given culture, or their assumptions, and are broadly appealing to an entire audience. The purpose of understanding and using audience enthymemes are because “enthymemes excite more favorable audience reaction” (p. 41). Aristotle uses the example of Olympic games: “for example, [to show] that Dorieus has on a contest with a crown it is enough to have said that he has won the Olympic games, and there is no need to add that the Olympic games have a crown as a prize; for everyone knows that” (p. 42). The key element in understanding enthymemes is in Aristotle’s last line, the unspoken assumption that “everyone knows that” (p. 42). In the transference of ideas from the complexity of science into the vernacular, scientific discourse employs the public’s notions of the sacred.

The study of values from a rhetorical criticism standpoint is the examination of enthymemes. Originally conceptualized by Aristotle and addressed later by thinkers whose systems of thought, enthymemes permeate the minds of individuals in cultures and are capable of being tapped by popularizers of science. Perelman and Olbrechts-Tyteca (1969) write that enthymemes function in all discourses, including science, “In most cases, facts and truths (scientific theories or religious truths, for instance) are used as separate objects of agreement, between which there are, however, connections that enable a transfer of agreement to be made” (p. 69). All rhetors work to tap into themes already present in the minds of audiences, “When a speaker selects and puts forward the premises that are to serve as foundation for his argument, he relies on his hearer’ adherence to the propositions from which he will start” (p. 65).

We need to understand why enthymemes must be tapped in the first place. When dealing with issues beyond fact, rhetors must employ artistic proofs. Perelman and Olbrechts-Tyteca highlight the differences between argumentation and demonstration. In the hard sciences, the impersonal nature of demonstration is sufficient for persuasion. Yet when an argument cannot be grounded in demonstration, the argument moves from demonstration and therefore enters the realm of argumentation. With such appeals to logic comes the capability of using enthymemes, which will lead audiences to follow the logic that the rhetor prescribes. String theorists, lacking demonstration (meaning unable to provide experimental data as evidence), move to argumentation. In doing so, they must begin in the stage of rhetorical invention. Invention requires tapping into audience enthymemes. Ultimately, the task of constructing scientific knowledge becomes priority. The following chapters demonstrate how string theory discourse is shaped to address enthymemes of the sacred, and do so with the strategic maneuvering of Aristotelian artistry.

Platonic vs Aristotelian notions of invention

The challenge of crossing the abyss from technical theory to public, accessible language is a difficult one for scientists. Yet whether or not one believes they are employing rhetoric to get from the technical side to another is a different discussion; and it is a lasting discussion which goes back to the rival conceptions of rhetoric between Platonic and Aristotelian philosophy. These two conflicting yet eternally intertwined perspectives on rhetorical theory are the backdrop of the performance of rhetorical analysis in the following chapters.

This conflicted existence is where string theory proponents operate in their presentation of string theory. Yet it is a dilemma that has transcended time. Claims about reality, particularly in the case of a scientific movement are designed to offer vernacular audiences an understanding of the complex laws of nature. This tendency is a Platonic process of seeking to reach transcendent realities. As it is a process of believing in transcendent realities, we get images of scientists grimacing as they have to dip their hands into the slime of rhetorical persuasion in order to convince their audience of the existence of such a transcendent reality. I speak of the employment of language as slime because of the Platonic desire to be free of employing rhetoric. Aristotle tells us that rhetoric, whether sacred, technical, or anything else, is always present in human civilization.

Plato was an idealist and his view of Truth made him very distrustful of rhetoric. In the *Gorgias,* he portrays Socrates excoriating the civic uses of rhetoric in Athens. They spoke not out of a motive to convey the truth, which they did not know, but from an interest in partisan advantage. For Socrates, rhetoric was the false art, which was used to cleverly sway the ignorant crowd. Yet, Plato recognized how rhetoric was necessary to give expression to Truth. He represents this process is the *Phaedrus*. This work is filled with allegory and soaring metaphor. For Plato, philosophy and the process of dialectic drive invention.

According to Plato, the morally, ethically blind have no grounding upon which to lead others in the right direction. Near the end of their discussion about when rhetoric must be used by a philosopher, Socrates says to Phaedrus, "Until someone knows the truth of each of the things that he speaks or writes about . . . he will not be able to handle with art the class of speeches . . . either for teaching something or for persuading something" (p. 88). The use of rhetor is therefore, unless a philosopher like the one Plato outlines, merely a person who is separated from reality.

Aristotle’s conception of rhetoric is quite different. For Aristotle, invention is such an important process that the very notion of rhetoric is an act of invention. George Kennedy’s (1991) translation of Aristotle’s definition of rhetoric is “Let rhetoric be [defined as] an ability, in each [particular] case, to see the available means of persuasion” (p. 36). In short, what Plato calls an attempt to create a rhetorical argument is, in the perspective of Aristotle, rhetorical invention. Aristotle argues that rhetorical invention leads to discovering tools available for rhetorical praxis.

What follows in this discussion is the separation of these two schools of thought on the idea of invention. I first outline the Platonic perspective, which is a tradition that frames invention as a fluid process that is ever separating us from the real. The Aristotelian opposition to that perspective gives us something more concrete and systematic on how rhetorical invention works and in relation to this project, scientific discourse that is geared toward meeting the needs of a public audience who does not have specialized knowledge.

Amidst my discussion of Platonic and Aristotelian traditions of thought, I must mention the irony that takes place in the string theory movement in its relations to both of these traditions of thought. Reason is: due to string theory arguments for a transcendent reality (multiple dimensions), proponents of the theory are incredibly Platonic. The very foundation of their arguments means proponents lend themselves to a Platonically grounded explanation. Another similarity is that like Plato these theorists cannot separate themselves from the usage of persuasion. Plato had to engage in rhetoric in order to get his point across. At the same time the appeal to arguing for a complex universe, string theory proponents engage in Aristotelian artistic proofs in order to convince an audience of the existence of, even though not a heavenly transcendent reality such as Plato taught, but in a universe where there are dimensions unseen.

Platonic invention

Platonic invention is based on belief that an audience can be brought to higher knowledge by an expert. Audiences become accustomed to the scientists doing the work of explaining the mysteries of nature to them. Built within this rhetorical situation is a hierarchy of knowledge. With the advent of science knowledge over the past several centuries, scientists have come to fulfill a function in the lives of people in the same way religious leaders have in ages past. Thomas Lessl (1989) calls this the “Priestly Voice,” where scientific discourse takes on an authoritative position for the non-scientific community. As the scientific community employs this “Priestly Voice,” vernacular audiences adhere to science as the explanation of the mysteries of nature. And as scientists offer transcendent solutions to well understood problems scientists play a Platonic role in the public, similar to Plato’s Socrates playing the role of hero in the dialogues.

When science is presented at the public level, it is used to discuss particular problems and how scientists have the knowledge to address those problems. Nonetheless, as science enters the public domain, its rhetors have no choice but to play by the rules of argumentation conducive to the particular culture in which the debate arises, “Social dramas move from threat to resolution; whatever the outcome of a particular conflict, cohesion is normally maintained: whoever wins, society is not the loser. By means of its social dramas, then, society attempts to turn public controversy into a reaffirmation of existing values" (Gross, 1996, p. 180).

Scientific discourse is persuasion, just as Platonic dialogues are persuasion. Persuasion is a craft mastered and used within science, and it is the art by which physicists convince one another. Yet it is also an art that scientists must master as they address the non-scientific community. In this context, scientists must be able to situate their claims within the assumptions of their readers, such as their beliefs about the world and its history. If scientists are in touch with the real, they must put it in a simplified form in order to explain it to an audience. To do so, scientists must situate their arguments in a language and form that will allow the audience to understand. Chemist Theodore Brown (2003) argues that scientific rhetoric is always situated within the historical circumstances, which offer scientists the various choices that can be made for persuasion:

> It is also true that scientists are influenced by social experiences with the many complex entities that constitute the economic, social, and political life of any contemporary human community. So it is quite correct to say that culture as well as embodied experience shapes the scientist's understanding of the world and influences choices of subjects for study and approaches to the studies themselves. (p. 191)

These connections between scientific discourse and cultural trends and values are essential to the study of popular science. Scientific persuasion in science is driven by the challenge of connecting scientific ideas with the cultural value system in attractive metaphors that can tap into the sacred of the given culture. "Arguers in science," Prelli (1989) writes, "continually use an identifiable, finite set of value-laden topics as they produce and evaluate claims and counterclaims involving community problems and concerns" (p. 3). It is a complicated and difficult process.

The Platonic reality that is meant to be realized through revelatory teaching in philosophy cannot escape the usage of Aristotelian artistic proofs. String theorists do not write about their combining of Platonic philosophical foundations that are established for a public through the use of Aristotelian rhetorical strategies. Neither did Plato in his dialogues. Nonetheless, the rhetorical invention of a transcendent or extra-dimension reality comes through having a desire for a common understanding of the universe, which is what Plato wanted. Yet as such argumentation, whether it be founded in mathematics and translated into vernacular language or simply found in language itself, there is a translation that takes place from the technical to the vernacular. The translation takes place as Platonic arguers make sure their ideas operate on the level of the audience. They therefore borrow from enthymematic themes that permeate the cultural values of the audience.

Invention is typically understood as the impetus of thought. Platonic philosophy implies a built-in understanding that can be unearthed with strenuous intellectual effort. The discovery of that knowledge is then shared. Some scholars of invention theory think along this inventional process: thought-discovery-wisdom. Part of that wisdom is in experience. Original ideas are born out of, or transferred from, previous ideas and experiences. Like Plato, the assumption is founded on the notion that ideas come prior to experience with other paradigms of thought. Gordon Rohman (1994) demonstrates that invention is based on our experiences—what we have seen, experienced, and been taught.

> [W]hat sort of "thinking" precedes writing? By "thinking," we refer to that activity of mind which *brings forth* and develops ideas, plans, designs, not merely the entrance of an idea into one's mind; an active, not a passive enlistment in the "cause" of an idea; conceiving, which includes consecutive logical thinking but much more besides; essential the imposition of pattern upon **experience [**bold added for emphasis]. (p. 41)

In other words, original ideas emerge out of the context of experience which rhetors go through. Our capacity for invention is also understood as being determined by our past exigencies (Britton, 1994). In the process of coming up with ideas we are "drawing upon interpreted experience, the result of our moment to moment shaping of the data of the senses and the continued further assimilation of that material in search of coherence and pattern" (p. 151). In addressing audiences, we draw upon material they are familiar with in the construction of our messages.

So as scientists work to bring science to a public level, they are left to the resources, in their effort at rhetorical invention, of relying on the experiences and values that are foundational to the cultures, in which they reside. Invention in science is as much about re-situating the past as it is about creating what is to come. The premise is that original invention is always embedded with strains of borrowing from other thoughts in order for new ones to emerge, "Beginnings are acts of departure, but always departures from something, in relation to something" (Bawarshi, 2003, p. 2). Edward Said (1975) made a similar argument, "text stands to the side of, next to or between the bulk of all other works—not in a line with them, not in a line of descent from them" (p. 10). In

Platonic thinking we therefore see a dialectical consistency of improvement, of gathering knowledge. Yet, we are always being shaved away from the ultimate.

As scientists work to get audiences to understand their current arguments, they must construct histories that support and allow their arguments to be worthy of acceptance today. In such a translation process we step further and further away from the original, genuine product that was the impetus of thought. Other writers argue that invention has to do with the re-emergence of ideas into new language and into new areas, paradigms of thought, movements, and objectives in different ages. Drawing upon Michel Foucault, Karen Burke LeFevre's (1987) study of invention as a social act is based on the claim that invention has to do with ideas shifting and taking on new forms in new language:

> [Foucault] describes the beginning of a discourse as a re-emergence into an ongoing, never-ending process: 'At the moment of speaking, I would like to have perceived a nameless voice, long preceding me, leaving me merely to enmesh myself in it . . . There would have been no beginnings: instead, speech would proceed from me, while I stood in its path—a slender gap—the point of its possible disappearance.' Elaborating on this perspective, one may come to regard discourse as not an isolated event, but rather a constant potentiality that is occasionally evidenced in speech or writing . . . Such perspectives suggest that traditional views of an event or act have been misleading when they have presumed that the individual unit—a speech or a written text, an individual hero, a particular battle or discover—is clearly separable from a larger, continuing force or stream of events in which it participates. (pp. 41-42)

At least one strain of contemporary understanding, then, treats invention as the process of drawing upon various historical ideas as they are floating about, ready to be grabbed and put together into a new puzzle.

Another way to understand the Platonic tradition is that invention is about ideas constantly travelling, constantly taking on new form, "The uncountable previous turns of the conversation in which it is embedded and out of which arises the knowledge that the next rhetorical exchange will further modify" (Brent, 1992, p. 11). This has been called "originating consciousness," which is where invention begins (Crowley, 1990, p. 16).

Platonic invention is interested in humanity's inevitable separation from reality and the attempt to get back to it. Yet the slipping away from it as ideas are constantly translated from one level of expertise to simpler levels of understanding is a constant symptom in the Platonic perspective. Platonic invention is important as it would be best applied as a theoretical foundation for a rhetoric of inquiry project where science specialists write to convince each other. After all, at such specialized levels the idea is not to persuade, but to understand the mystery under examination in as perfect detail as possible, or in the world of Plato to become the Platonic philosopher. However, we are talking about translation to the public, a civic discourse, a civic scientific understanding of the string theory movement. In exploring such, we are interested in the "available means of persuasion" that are found by science writers. But in realizing we use Platonic rhetoric we do not leave the Platonic dream, for public science is riddled with appeal to transcendent dimensions.

Aristotelian invention and public science

Aristotle, the most noted student of Plato, was a realist. He understood that people must work in a world of contingent affairs. You do the best you can with what you have. From this conviction, Aristotle produced the ancient world's crowning achievement in rhetorical theory, the *Rhetoric*. He put at the center of this theory, the first canon of rhetoric, invention. He defined rhetoric as the "ability of discovering the available means of persuasion in any given circumstance" (p. 36).

Language and suasory-minded thinking are ever-present. Here we also turn to the gist of scientific rhetoric and the roles of persuasion in public argumentation about technical knowledge. As we move into a discussion of how Aristotelian invention works, we connect it to scientific notions of argument in the public sphere. As we move further into Aristotelian invention, we dive deeper into a process in which scientific discourse becomes increasingly Platonic as the Aristotelian proofs are employed. The structure of this argumentative process begins with an understanding that science is situational and based on the addressing of exigencies. We realize that there is no direct translation of technical knowledge being framed into vernacular terminology. In the ornamentation of scientific theory, the narrative form of scientific discourse takes on romantic form. Finally, such a romantic form suggests a millennial peace and resolution is presented. Romanticism permeates the string theory story from beginning to end.

The challenge for invention in the Aristotelian tradition is that it is accomplished via transference from other traditions of thought. In the case of this project, it is a scientific movement. This is not an easy process. In addressing popular audiences scientists must both remain scientific yet operate on a vernacular level. In the invention process, scientific rhetoric is a transparent process. It is difficult to even realize it happens. It is not understood as a rhetorical process, but simply the discovery of knowledge, and not something that is affected by cultural understandings of reality.

Prelli argues that scientific invention is driven by motives within the particular cultural circumstances within which science is situated, “the rhetoric of science is strategically *created* with a view to securing acceptance as reasonable . . . It is based on a particular type of topological logic” (p. 258). Even further, Prelli writes that scientific discourse, before it is even created, comes with the purpose of the persuasion of particular audiences in mind, “partly guided also by what seems likely to persuade their situated audiences, scientific communicators choose from among certain standard topical lines of thought peculiar to scientific discussion” (p. 259).

Part of the cultural systems which scientists must understand and then engage in is the invention of vernacular scientific discourse as they appeal to political preferences to which citizens subscribe. Perelman and Olbrechts-Tyteca (1969) tell us that for rhetoricians to succeed, their ideas must be transferred to the kinds of talk that audiences are drawn toward,

> There is thus a considerable mass of elements that is compelling to the hearer or which the speaker strives to make compelling. They may all be challenged and, so, lose their status as facts. But, as long as they enjoy this status, they must conform to those structures of the real that are accepted by the audience, and they will have to be defended against other facts that may compete with them in the same argumentative context. (p. 68).

Scientific efforts at invention are geared toward bringing claims to the public. In doing so, rhetoricians of science engage previously understood ideas. They are rescrambling ideas that create new language, new terminology. Regardless, it is apparent that scientific invention requires drawing upon cultural assumptions held by the public audience, which will ultimately allow the science rhetor to have a connection with their audience.

The challenge for the rhetor is finding linguistic resources with which to translate complex formulations into non-technical language so the public may delight in scientific advances. Rhetorical invention involves figuring out what will be persuasive. Aristotle identified invention as the first canon of rhetoric. Invention is the very impetus of thought, and, further, the capacity to put scientific claims into common language that will convince the audience. Without empirical explanations, string theorists find invention from some vernaculars in order to address public audiences. The means for scientific invention is borne out of other scientific ideas that were pursued, although put into different terminology, “there are in fact identifiable lines of thought that are used again and again in the sciences,” and “these lines of thought legitimize scientific observations and claims because they derive from what is accepted and valued in scientific communities” (Prelli, 1989, p. 216). In other words, ideas are established within science before they are shared outside of the scientific community.

Aristotle writes that some ideas are in their very nature difficult to grasp and understand in the first place. Some ideas, while being composed of obvious, factual knowledge, could end up being rejected by audiences with certain dispositions that would be contrary to the speaker’s proposed idea if rhetoric is not employed by the rhetor correctly. Knowledge in and of itself is not enough to get audiences to believe, so we must move to establishing common ground between rhetor and audience in order for ideas to be accepted by audiences. Aristotle states,

> Further, even if we were to have the most exact knowledge, it would not be very easy for us in speaking to use it to persuade some audiences. Speech based on knowledge is teaching, but teaching is impossible [with some audiences]; rather, it is necessary for *pisteis* and speeches [as a whole] to be formed on the basis of common [beliefs]. (p. 35)

Scientists confront the challenge of expressing claims that transcend empiricism. In this context, invention is the rhetorical canon charged with finding materials to move the audience across this cognitive chasm where scientists stand on one side and need to find a way to get their audience over the abyss.

While Aristotelian rhetorical theory became the curriculum for teachers of rhetoric, the Platonic denial of rhetorical invention as an ever-present process prevailed. The tension on the function of rhetoric continued during the European Enlightenment with the rise of modern science. For Descartes (1637), rhetoric was the enemy of science. All that was necessary for explanation and persuasion was to restate the method of discovery for the audience. Yet, the inadequacy of such a suggestion—perhaps the very impossibility of such a transparent use of language—became obvious.

For all of Plato's complaints, Truth is given expression through the inventional choices described by Aristotle. Truth is not independent of culture. Truth is given expression through the storehouse of commonplaces recognized by the audiences to which discourses are addressed. This process of invention shapes their popular meaning and reception.

The following chapters demonstrate how scientific rhetoric is Platonic in purpose and Aristotelian in execution. Even in the most advanced sciences, it is impossible to escape the ever-present (Aristotelian) yet subtle (Platonic) strains of rhetorical practice.

Analysis chapters

In Chapter 3, I examine the situational exigency that organizes string theory discourse. The contradictory conventional paradigms of physics fix the problem string theorists set out to solve. This exigency is expressed in a discourse of division. The implications of overcoming this division are the subject of chapter 4.

In Chapter 4, I examine the millennial promises of string theory. In this chapter the artistic appeal of unification becomes vivid. I examine the rhetorical methods employed by string theorists in relation to the translation process. Chapter 3 addresses heavily the setting up of the division between established physics theories. Because of division, the discussion of unification in chapter 4 then becomes a strong possibility for audiences. String theory is the rhetorical process these rhetoricians are employ as they convince their audience of the necessity of unification. The process includes convincing audiences of the significance of incompleteness, the beauty of unification, and the peaceful restitution of bringing all into one. This dream has existed for a long time.

Chapter 5 is a study of the grand Theory of Everything as secular salvation. The last chapter will explore the implications of the secularized, scientific reconstruction of the salvation narrative that string theory promises. The theme I follow is that rhetoricians justify the importance of unification, stress unification, which then allows the appeal for the Theory of Everything to be the conclusive argument, and by implication give us a secularized salvation story. We are unified and are brought to a new understanding of the universe that is based on the near impossibility of understanding the mysteries of the universe.

As I conclude the study in chapter 6 I outline some of the reasons string theory works in creating a secular salvation. The movement has spiritual implications. The discourse, as shown in the analysis chapters, is richly theological in the types of language and metaphors employed. Because of these factors, the scientific understanding of the universe offers us a form of salvation because many of our questions about the cosmos, or our own history as humans are answered. It is scientific in form yet theological in implication.

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Chapter 3

Emphasizing Division, Establishing Guilt

In chapter 1 I outlined the basic story of string theory and its emergence as a paradigm-shifting theory of physics. Yet that story was not detailed, not complete. There are levels of argumentation, of metaphor, and of evocative language that makes the string theory story dramatic and that makes it rhetorically rich. Stories of despair and shame permeate the feelings of readers who follow the tale of the string theorists who struggled to fight for their theory against the powerful armies of those who set up camp in quantum mechanics and general relativity.

Before I turn to the analysis, I need to explain the levels of argumentation, which take place in string theory rhetoric. At the level of the reader of popular, vernacular, string theory rhetoric is the consumption of the dramatic story. We are reading stories of things which happened in the past, and because of that past there is a promising and bright future. We watch the story unfold, but we are not part of the drama. We are the spectators watching the warriors in the arena; or perhaps stated differently, we are the audience who watches actors in a play who engage each other. In short, we are separated from the event as observers. On another level, there are the stories of the string theorists who struggled and sacrificed for the theory. We watch them struggle and triumph. Although while we are observers, the drama gives us a kinship with the protagonist string theorists as they embark on their journey. The rhetoric of the story navigates between both of these levels, showing the emotions of the people involved and also using descriptive words of the events, which help us to capture the mood of those past events.

The interweaving of them help to situate us as followers of the string theorists who witnessed the division in physics we learn about.

It is important to understand these two levels of the narratives because the focus of this chapter, division, operates on both levels. And division is an exigency, a real problem that string theorists are working to resolve, yet here we have a scientific issue, at least from our perspective, being resolved through an emotional tale of protagonists where dragons are slain through heroic effort. As readers of vernacular string theory literature, we are on the outside looking in, so we are brought to viewing a drama. As audiences, division for us is something that *happened*. But for the string theorists we are following in the story, it is something that *is happening*. Our connection to the string theorists is accentuated by the division and the emotional impact that the metaphors and language employed when the theory's proponents retell the string theory story. We come to understand and want to resolve the division because the string theorists themselves did.

In chapter 2, I drew upon Lloyd Bitzer's (1968) work on exigencies. Yet the exigency that string theory faces is not able to be understood nor resolved in a cut and dried form of critique. Rather, the vernacular rhetoric of science works through drama with complex characters, plot, and passionate language. In this chapter, we explore that complex challenge for string theory and its proponents.

We see them as protagonists; they are on a journey to resolve division. Northrop Frye (1957) describes the genre of romance as a tale of heroes who function symbolically in a religious-themed mythos. Frye says the hero takes on the daunting task of saving the world and doing so by employing powers that are beyond mortal capacity. For persuasive effect, the string theory narrative is told as a romantic journey of coming to the rescue. In this chapter I outline the task that string theory proponents place before string theory. It is because of division that string theory is able to resolve and become the hero.

Rhetorical invention is the art of making choices to create intense and captivating drama. The metaphors and language used in creating this process works to invent a rhetoric of need, an unsettled feeling of pain that desperately requires resolution. Rhetoric succeeds by creating needs and also by satisfying those needs. Rhetorical invention constructs the language and metaphors used by the speaker. Here the rhetors of string theory invent shame, which is the result of division in physics. In this chapter I unearth the linguistic choices which invent a need for redemption from a disturbing condition in physics, and ultimately as I discuss later in this dissertation, a rhetoric of atonement. In the tradition of Frye and literary criticism, Hayden White (1973) tells us that language choices, or specific kinds of words, drive our coming to see historical events because “plot structures” cannot exist without “linguistic protocols” (p. 426). I demonstrate how such word choices create a history and therefore a need for resolution in physics.

The rhetorical texts examined in this project include a couple of documentary programs, numerous books, which include titles such as *Dreams of a Final Theory* (Weinberg, 1992) and *Superstrings and the Search for the Theory of Everything* (Peat, 1988). At the beginning of the popularization of string theory, many of the accessible articles were published by scientists themselves in popular science journals. I draw upon articles in *Discover, Physics Today, Science,* and *Scientific American*. These articles and books are written by both scientists doing the research and science journalists who report on scientific research. While many articles in *Science* are readable only by mathematicians and theorists in specific fields, many of its essays are written with an eye toward public accessibility.

Within string theory rhetoric division has a structure, by which the seriousness of the issue escalates. String theory discourse begins with a first theme that I encapsulate as separation—simple, explicit wording, which explains theoretical differences. Here the language is plain and non-threatening, it simply points out differences. Yet because of the great separation, a rhetoric of distress emerges, which is the second theme. The realization of difference creates an intensity, in which the reader sees the division of theories of physics as beginning to suffer. Strains of regret for such division are present in the language and metaphors used in the theme of distress. Finally, we come to the rhetoric of shame as the climactic theme, due to the embarrassing theoretical impasse between quantum mechanics and general relativity. The linguistic choices in this theme function to bring the greatest feelings of regret, of wanting to recover, of wanting to be saved.

The concept of division

Division is an important part of rhetorical processes. Kenneth Burke (1969) argues that human beings are bound to deal with conflict. In working out of a theory of dramatism, Burke says that as humans we deal with conflict and pursue “peace” (p. 45) through language that is designed to bring about identification. However, in order to achieve identification humanity creates “division” (p. 45). Division has significant cultural and mythic conceptions that drive the nature of any story that is told. So, this leads us to ask about the nature of the drama that is unfolding. In the present analysis, we are talking about a scientific movement that uses a strategy of division and therefore creates a unsettling in the audience. Burke situates division at the heart of achieving persuasion. More detailed than in the *Rhetoric*, Burke further developed his idea on division and language in the *Grammar* (1969) when he explains that division is a process which allows scapegoat to take place, "a principle of division, in which the elements shared in common are being ritualistically alienated" (p. 406). The ritual spoken of here is found in practices of language, or stated better as the practice of rhetoric.

As I write about division as a strategy used in string theory, I need to emphasize that "division" is not a term used by string theorists. Rather, it is a Burkean process that I demonstrate is used in string theory discourse. That is, string theorists scapegoat traditional theories of physics in order to provide a satisfying solution via string theory. String theorists do this by dissecting the problems with quantum mechanics and general relativity. Therefore, what I describe as processes of division are nuanced patterns in string theory. In short, string theorists do not employ the word "division" as a common rhetorical strategy in their discussion of the problems they demonstrate are present in theoretical physics.

Demonstrating division within the world of physics is successful in that it becomes personal for the reader; they come to feel shame for physics because of the division. Arguing on an individual level, in which audiences will understand the problems within quantum mechanics and general relativity is what makes this discourse powerful enough to persuade the reader to feel disturbed by the division in the two established paradigms of physics. In a way, this sense of division and the internal desire, which comes by realizing the rift within science functions as what Istvan Csiscery-

Ronay, Jr. (2008) referred to as a "grotesque" experience in the reading of science literature (p. 146)? The realization that the laws of nature do not fit together creates a personal crisis for readers who engage popular science literature.

Separation

The challenge to establishing string theory as a paradigm of physics is that many physicists do not give attention to the contradictions between quantum mechanics and general relativity. Therefore string theorists face the burden of bringing to the surface for vernacular readers the details of physics' contradictions by describing a different history of physics than has been told, one that describes the division of paradigms. The difficulty that string theory faces in achieving effective persuasion from the non-scientific community is the illumination of the problems between contradicting laws of nature. String theorists emphasize contradictions between general relativity and quantum mechanics as the foundation for their argument. The first step of illumination of the contradiction is polarizing established laws of physics. Of the three themes, separation being the first, the language in this section is the friendliest—the following themes, which build off of this one, are more intense. The separation theme is part of the story that we witness physicists experience as they worked to mathematically formulate understandings of the laws of nature. Separation was a strategy physicists used from nineteenth century physics, such as the efforts of physicists who were embarrassed by the work of Zollner after his association and defense of the magician Henry Slade.

Separation begins with string theory writers presenting the division of established theories of physics as obvious—that it is common knowledge that everyone should understand. These writers insist their audiences see the obvious nature of the division. Weinberg (1992) calls theoretical differences in established paradigms, namely quantum mechanics and general relativity, an "obvious obstacle" (p. 200). Weinberg also refers to these obvious and clear challenges as "apparent differences" (p. 200). The world of physics becomes increasingly confused about the underlying, mysterious laws of nature, even though we know much about the universe already, "there is an irreducible fuzziness or vagueness in the activity of the quantum system" (Davies & Brown, p. 19). "Vagueness" brings a sense of obvious lack of detail, or what Michael Green (1986) in one of the first widely spread science articles in popular science literature on string theory called a "basic difficulty" (p. 48). Witten describes how the two theories are separate because each of them is "only approximations of the truth" (p. 24). And University of Michigan's Michael Duff (1998) helps to magnify the difference between the two, stating that the only thing in common with the theories is how they realize how different they are, they are "mutually incompatible" (p. 64).

The "obvious" nature of the division in these theories leads readers of string theory literature to seeing the issue as a problem that the arguing physicists were facing in the story, which is the second function of the separation theme. The word "problem" is associated with statements such as being invited to feel incomplete, to feel polarized: "The theory of relativity invites us to relinquish some cherished notions" (Davies & Brown, 1988, p. 18). Davies and Brown call the difference in established laws of physics "severe theoretical problems" (p. 26). University of Minnesota physicist Eric Ganz (1987) refers to such divisions in physics as "concrete problems" (p. 1969). Duff adds that such theoretical understandings "fails to comply" (p. 64). Of course, problems arise because things become difficult, challenging, and even overwhelming. Trying to fit established theories together can make things “hard to reconcile” (p. 18). These kinds of descriptions of the story were not as concrete as was thought. Take this into consideration with the early movements in physics where division started with physicists finding evidence that the dominant scientific ideas of particles were contradicting other experiments on particles. Namely, within the string theory literature as Tulio Regge and Roger Penrose began discovering odd behaviors of particles and worked to extend the understanding of particles as more than simply spherical, hard points. Brown and Davies use a metaphor of music to describe the incompatible nature of the theories, stating that they are “different musical notes” (p. 93).

In the opening scenes of the three-hour documentary *The Elegant Universe*, Brian Greene is at the house where Einstein passed away. The story begins with a haunting scene. The house is dark; it is cloudy and foggy outside; and the music is eerie. Brian Greene emerges from the house and begins to explain how Einstein never gave up on finding a unified theory. He explains Einstein’s death:

> Einstein spent the last two decades of his life in this modest home in Princeton, New Jersey. And in the second floor study, Einstein relentlessly sought a single theory so powerful it would describe all the workings of the universe. Even as he neared the end of his life, Einstein kept a notepad close at hand, furiously trying to come up with the equations that would come to be known as the Theory of Everything. Convinced he was on the verge of the most significant discovery in the history of science, Einstein ran out of time, his dream unfulfilled.

The words Greene uses capture the essence of division as a problem. Einstein worked "restlessly" and "furiously." These painful words show the feelings that Einstein must have been experiencing. These descriptive words, along with the phrases that show Einstein felt "unfulfilled," leave the viewer of this film realizing the laws of physics are incomplete, they are far apart. Weinberg uses the word "incomplete" to describe the current state of physics (p. 6).

String theorists use the public forum as an opportunity to dramatize division for us as observers. Consider Brian Greene's invitation to the TED (Technology, Education, Design) Conference to explain string theory, in a straightforward fashion, to the most intellectually curious of audiences. Each year fifty influential thinkers in the world are invited to attend and present their ideas in less than eighteen minutes. Made up of attendees who pay $6,000 per seat (TED, 2009), the brightest minds who propose the most stimulating ideas in the academic world are invited to attend and mesmerize the audience. Political figures such as Al Gore and Bill Clinton have attended, along with award winning journalists. Such a task—the explanation of complicated ideas to a non-expert audience in a very short time--seems extremely difficult to do. After all, these intellectual rock stars are billed as offering "inspiration from the world's most inspired thinkers" (TED, 2009).

The opportunity for Brian Greene to make a presentation at TED was the result of an already burgeoning interest in string theory. Popular science outlets had created a string theory phenomenon. I use the word phenomenon because knowledge of string theory was spreading.

The significance of the event, and particularly Greene's presence at TED, has been recognized. Learningoutloud.com is a database, which archives collections of educational materials that stimulate the intellect. Contributors (2009, April 29) to the site rate the top TED talks ever given, with Greene's talk coming in at number fourteen. Through a careful examination of hundreds of the talks, the creators of learningoutloud.com describe their top choices,

> We recently became addicted to watching and listening to talks from the TED Conference. The Technology, Entertainment, Design (TED) Conference has been featuring talks from leading thinkers not only in technology, entertainment, and design, but also religion, science, literature, psychology, personal growth, and numerous other areas. Their archive currently features over 400 talks from the TED2005 conference up through TED2009 . . . Here we're showcasing 15 of the most popular TED talks which we certainly enjoyed and did some write ups on. We'll continue adding to this Best of TED Talks list as we watch and listen to more talks that we find to be particularly excellent.

Learningoutloud.com's description of Greene's performance explains how the listener can come to understand the deepest theories of physics with Greene's help,

> Try wrapping your mind around string theory with this TED talk delivered by physicist Brian Greene. He starts the talk with the story of the German mathematician and physicist Theodor Kaluza who proposed that the universe might have more dimensions than the three-dimensional space apparent in the physical world. This led much later to the attempt at discovering a unified theory through string theory and superstring theory which proposes 10 dimensions. Brian

> Greene ends the talk with describing some experiments which are being conducted that could lead to proving the existence of other dimensions.

Greene's capacity to explain complex physics in an eighteen minutes exemplifies the potential of this scientific breakthrough to capture the imagination of a wider public. In his presentation he uses the same strategies employed in popular string theory explanations that can be picked up at Barnes & Noble. Greene addresses the significance of early pioneers, and magnifies the importance of the theory by addressing the division between quantum mechanics and general relativity.

To be more specific, Greene begins as all effective string theory discourse begins: by telling us about important, established theories in physics. Greene paces back and forth as he introduces his audience to Theodor Kaluza. Greene explains how Kaluza was troubled by the ideas of Albert Einstein's theory of general relativity in the early twentieth century,

> In the year 1919, a virtually unknown German mathematician named Theodor Kaluza supposed a very bold and in some ways a very bizarre idea. He supposed that our universe might have more than the three dimensions that we are all aware of, that is in addition to left-right, back-forth, up-down. That there might be additional dimensions of space that, for some reason we don't yet see. (About TED, 2009)

Greene goes on to explain how Albert Einstein discovered that Isaac Newton had left out a great deal in describing how gravity actually works, and as a result Einstein found that space is actually a substance in and of itself. Kaluza was troubled by divisions in the theories of physics, then attempted to come up with a "master theory" of the universe.

More than anything, Greene leaves his audience wanting to transcend, wanting to overcome the divisions in physics that handicap our understanding of nature.

The most accessible, easy-to-read literature to non-scientists on the topic of division between general relativity and quantum mechanics is George Musser's (2008) *The Complete Idiot's Guide to String Theory*. Musser's book has six parts, which comprise twenty-three chapters. One of those sections is "The Great Clash of Worldviews" (p. 25). Musser creates a graph to illustrate the dichotomy of the two theories (p. 88), a rendition of which I re-create below.

General Relativity vs. Quantum Theory

Aspect	**Relativity**	**Quantum**
Basic idea	Space and time are unified and behave like a big sheet of rubber	Matter and energy are divided into chunks
What it explains	Gravity	Electricity, magnetism, nuclear forces
How it explains them	Matter distorts spacetime, and spacetime guides matter	Particles interact
Poster child	Black hole	Mighty atom
Sample use	Orbits of celestial bodies	Chemical reactions
View of spacetime	Dynamic	Static
Properties of matter	Definite	Probabilistic
Toy that represents it	Silly Putty	Legos
Worst failing	Predicts that matter reaches infinite density in black holes	Nobody knows what the theory really means

Musser is strategic in how he dichotomizes the differences between these two theories. The idea of a graph shows readers how to organize their understanding of the theories in their minds: line the theories up against each other, compare them, and see them as different in every way. With every aspect of comparison in this graph, readers are shown a contradiction. The "Basic idea" shows Relativity as saying matter is all working together in harmony, while Quantum describes matter as fragmented and independent.

They “explain” totally different things. Relativity addresses gravity, while Quantum addresses three forces that are seen as having nothing to do with gravity. They describe nature differently. Relativity’s variables are space and time, while Quantum’s interest is in the interaction of particles. The descriptive words also contradict, “Definite” versus “Probabilistic.” It is as if these two laws of physics are in different universes, different realities. Yet they are in the same universe. Weinberg says that quantum mechanics, despite the theory’s strong evidence, is “not . . . complete” (p. 237).

Musser stresses the size of the gap between quantum mechanics and general relativity, “Unifying relativity and quantum theory is a bit like the case of the irresistible force meeting the immovable rock. Both theories are based on compelling principles, but they can’t both be completely right because contradictions arise when we try to unite them” (p. 135).

Readers are left frustrated in the quantum and relativity chapters of Musser’s book. They are left wanting, desiring some kind of rest, some kind of closure. Musser gets to the point of highlighting the differences in the two paradigms later on in the middle of his book. An example that crystallizes Musser’s practice of establishing division is the analogy he uses of the irresistible force meeting the immovable rock.

Graphically juxtaposing different paradigms, such as Musser’s graph, polarizes the established theories because contradictions are emphasized. Freelance science writer Adrian Cho’s (2004) word choices create an understanding of the theories of general relativity and quantum mechanics as different kinds of substances, stressing that the “foam” of quantum mechanics cannot work within the “ripples” of general relativity (p. 1460). With foam we get the impression of a light substance that is used to address specific needs for softness. Yet ripples of general relativity create thoughts of moving water. When comparing these two theories in this analogy we end up with a mess if these two kinds of substances are combined. As a result, two kinds of substances are so foundationally different that the problem becomes frustrating.

Through separation, the reader or documentary viewer comes to understand basic differences. Yet the wording of the division in the established theories becomes stronger and stronger. As the division is further explained and as we watch the drama unfold for physicists who were caught up in the division battles, emotive words are used to create feelings and identification with the characters in the story. To be able to do that string theory writers first demonstrate how truly different, or how distant, the established theories truly are.

The separation of the theories of quantum mechanics and general relativity lead the audience to see a great distance between the theories. It makes incompatible theories seem more incompatible. It makes lack of union seem magnified, thus intensifying the problem. What we have is a great “theoretical impasse” (Green, 1986, p. 48) because the extensive differences in the theories make them unable to be viewed in any way from the other’s perspective. Steven Weinberg also refers to differences in theories of physics as an “impasse” that he says physicists must “break out of” (p. 4). Green’s and Weinberg’s word choice of “impasse” demonstrates the history of the two theories. Impasse implies already attempted efforts to reconcile. In this instance, Green’s word choice keeps the theories separated, incapable of being reconciled, at least on their own terms.

It is as if the theories are a great distance apart, so much so that they make impossible the existence of the other within each theory’s given paradigm. String theory discourse functions to create distance between quantum mechanics and general relativity. The distance metaphor as a part of separation takes on various forms for the proponents of the theory. Brian Greene's commentary describing the laws of physics as "lost" and "split" gives vivid expression to what is going on in the highest reaches of science (McMaster, 2003). The laws are so different that one can get "lost," as they are traversing a great distance." And indeed, the "split" metaphor widens the gap between the theories even more, and the difference in the theories becomes even more significant.

Weinberg (1992) calls the divisions between theories of physics a "problem . . . not only in physics but also in our efforts to understand the early history of our universe" (p. 198). Weinberg's extension of the problem from theoretical physics to the common understandings of the universe shows the extensive power of division in language that implies great distance. The problem extends to us as vernacular audiences. Not only are physicists left at a loss of what to do because of the difference, but we are left in the dark. The distance between the theories leaves our "common understanding of the universe" so distant that there is virtually no understanding at all because there is no ability to see a connection because the theories are so far away from each other on theoretical grounds. In his commentary in *The Elegant Universe* documentary, Witten adds, "We can't have one description for the elements and one description for the stars." In one of the first popular science articles on string theory, Michael Green (1986) calls this gulf of a division the "central paradox" of physics (p. 48).

The separation theme also applies in string theory rhetoric to other divisions in physics. In *The Elegant Universe* documentary, Brian Greene describes the challenge that Albert Einstein faced when he tried to connect gravity to electromagnetism: "the difference in strength between these two forces would outweigh their similarities." And that it would be an "uphill battle" to combine forces that had "wildly different strengths." The words "outweighed," "uphill battle," and "wildly different" imply vast differences. In being outweighed, a task becomes daunting. "Uphill battle" implies the difficulty of a trek, in which the physicists are traveling—indeed it is a trek that has a great distance, one that is too long for physicists to travel with only quantum mechanics and general relativity to accompany them. And "wildly different" brings a sense of different not only in function, but in makeup, such as two different cultures in which beliefs and behaviors are so different that the word "wildly" can be appropriately applied.

Harvard physicist Peter Galison states that the old theories were "totally inadequate" and "insufficient" when it comes to combining theories (McMaster, 2003).

In describing the division between the weak and strong forces, Weinberg uses the word "broken" (p. 199) to describe the theoretical difference and inability to link theories. Halpern (2004) adds that despite the eventually unification of many laws of physics, gravity was to be "left out" (p. 66). In Halpern's first chapter, in which he describes the "crisis" that is present in divided theories of physics; he asks the question, "What is the relation between relativity and quantum theory?" (p. 17). In the first paragraph of his book Halpern describes the relationship between the theories with the words "stubbornly refused to be reconciled," "paradoxical," "incompatible," "irreconcilable" (p. 17). "Left out" implies unable to find, neglected as progression continues in our knowledge of physics. This was no small problem, being that gravity has become, thanks to Einstein, the most studied law of physics being that general relativity is the key paradigm in astrophysics. Halpern adds that the inability to link gravity with other theories brought “major difficulties” and that scientists “could not detect” a way to bring closure to the problems of divided theories of physics.

The separation theme is magnified as we fail to “detect” a way to resolve problems in physics. As time passes and as theories continue to bifurcate, the “major difficulties” Halpern writes of the gap between the theories growing larger and larger. And as these difficulties grow and take up space in our understanding of physics, our despair of finding an ultimate understanding widens.

Ultimately, as Halpern stresses exhaustingly after his discussion of the divisions in physics, he concludes that “the two theories are still far apart” (Halpern, p. 11). This is because, in Halpern’s metaphor, the various forces of nature “act” differently and there is no way to get them on stage together (p 3). And they grow “far apart” as we fail to understand how they should fit together. Separation and difference foster desperation. As physics continue to pursue theories that describe the laws of nature, more questions arise between general relativity and quantum mechanics, as the theories are “still far apart.” The two theories are written to be “paradoxical” and “incompatible” (Peat, p. 17).

The separation theme begins to create a sense of urgency for string theory audiences. There is a sense of needing to resolve the issue. The theoretical challenges that keep quantum mechanics and general relativity apart begin to function as the audience’s reality. The separation seems far for the reader just as it does for the exhausted physicists. The inability to arrive at a conclusion due to the great distance leaves the reader exhausted, desperate, and frustrated. Yet the language in string theory discourse only strengthens in the creation of the need, in the demonstration of the awfulness of the division.

Distress

Separation creates distress. This is the beginning of the stress that created an unsettling feeling within string theory discourse audiences. In describing the consistent failures at combining the polarized theories of physics, the years of frustration lead to physicists losing hope.

Because of the theoretical division between quantum mechanics and general relativity, some physicists had “given up on quantum gravity as hopeless” (BMS, 1985, p. 17). The key word here is “hopeless.” These words of despair come from the disheartening differences, which Weinberg refers to as “unnecessary complication[s]” (p. 224). Distress explains feelings of wanting to abandon after repeated failure. The challenge of being so divided brought on feelings for physicists, which Halpern describes as “overwhelming” (p. 11).

No matter if physicists tried to move on, the division of quantum mechanics and general relativity was always lurking in the minds of the thinkers who could not find a way to understand gravity at the quantum and atomic levels. They were haunted and had to deal with “underlying problems” in the division between the theories which, in their minds, “remained” (p. 12). “Remained” in this instance carries a sense of feeling mentally tormented by an unsolvable riddle. Witten (1996) writes that the division was leading to “upheavals” within physics (p. 24). Witten’s phrasing of “upheavals” function to accentuate the seriousness of physics’ lack of unity. His wording demonstrates the intensity, which must accompany the efforts to find a link between the two paradigms.

Like others, Witten optimistically prepares to move into the solution as he continues his article by first creating the conditions which bring about the desired solution. This, in combination with what S. James Gates Jr. (2006) referred to as a branch of the sciences where "the conventional wisdom of the field has sometimes changed chaotically" (p. 54), help us understand that the integration of string theory brought more reason for physicists to be distressed, despite their already unsettling feelings toward each other.

Part of the distress in the division is illustrated in the titles of discussions. Halpern (2004) titles his subheading on the topic "Clash of the Theories" in his chapter describing the historical division of physics (p. 67). Peat (1988) begins the first chapter of his book with the title "A Crisis in Physics" (p. 9). Distress is often used as an opening statement as well. Peat's (1988) *Superstring and the Search for the Theory of Everything* begins with the exclamation, "Physics today is faced with a series of questions that must be resolved before we can truly say that we have significantly advanced our understanding of the universe" (p. 9). His key works add emphasis: "must be resolved."

The predicament is an introduction to another metaphor: marriage, "”The predicament is like that of two perfect people who want to marry the perfect spouse. They find each other, and you can practically hear the violins in the background. But because both think of themselves as so perfect, they are unwilling to make the compromises needed to live together" (p. 19). Musser also uses the irreconcilable differences theme in his marriage metaphor to create distress between quantum mechanics and general relativity. He says that the two theories are in a "predicament" (p. 19).

The metaphors used in this analogy capture the kind of distress physicists go through. The pain of torn marital relationships is applied to demonstrate the impact of division in physics with metaphors of “predicament,” “unwilling to make the compromises,” and “think of themselves as perfect.” The wording in these metaphors create need through a distress in which both theories are condemned for such “unwilling[ness].” This tradition of fighting is also prevalent in reaction to string theory, from the perspective of those in the paradigms of quantum mechanics and general relativity, what Musser referred to a reaction to string theory in physics as the “20 Years’ War” (p. 278).

Distress is also associated with pain and discomfort. Science journalist Mitchell Waldrop (1985) calls this a “quandary” which theorists were forced to face (p. 1251). Halpern quotes nineteenth-century Scottish physicist James Clerk Maxwell, who wrote that his “soul is an entangled knot,” at the thought of extra dimensions being a branch of study of physics (p. 6). Such pain has caused physicists to face challenges, with which they have “struggled.” Further, Halpern calls the issues of the division in physics a problem that is “the burning issues of modern physics” (p. 9). “Burning” can imply importance, such as popular press discussing a popular topic as “burning.” Yet “burn” also implies pain. Such pain is always associated with what is happening in the minds of physicists. Davies and Brown (1988) use the word “conflicting” to describe the mental state of physicists in their realization of the great division between quantum mechanics and general relativity (p. 10). He writes that such “conflict” leads to “restriction.” Harvey writes that physics’ has “suffered” because of “certain mathematical inconsistencies” (p. 125). Eric Glanz (1987) says that such inconsistencies in physics lead to misunderstandings that ultimately “explode” and lead to “failure” (p. 1969). In an interview, Witten twice uses the metaphor "headache" to describe the rift between quantum mechanics and general relativity has caused physics (Brown & Davies, p. 94).

The ultimate torment is to "never be at rest, "as Halpern states. It is also a "plague" according to Harvard physicist Jeff Harvey (1987) because physicists have always been "met with less success" (p. 10). The plague metaphor is also used by the *Physics Today* writer who goes with the acronym BMS. BMS (1985) writes that such differences have been "plaguing quantum field point-theories" (p. 17). Witten also uses the term "plague" in his description of divided laws of physics in his 1996 *Physics Today* article. Schwarz (1987) appeals to the pain theme with the word "severe" in his description of the "problems [that] arise when the resulting system is interpreted as a quantum theory" (p. 35). Weinberg uses the same language when he describes the challenges of quantum mechanics as he explains the strong evidence that supports quantum mechanics, yet is full of complications because it does not fit with other theories, "In quantum mechanics the problem is even worse" (p. 224).

Another, and perhaps the most compelling, form of distress is the failure theme that is present in physics because of the division. Halpern writes early in his book of "the failure of physics to reconcile relativity and quantum mechanics" (p. 10). BMS calls such failed efforts "hopeless" (p. 18). Hopelessness comes through feelings of being "lost," a metaphor that serves the separation theme. Peat adds to the "lost" characterization when he writes that the difference between the two established theories have failed to provide a "path" out of the "wilderness" (p. 340).

Another theme of distress is inability to not get along, the battle metaphor. In *The Elegant Universe* (McMaster, 2003), physicist James Gates says, "You try to put those two pieces of mathematics together, they do not co-exist peacefully." He adds that: "The laws of general relativity are supposed to apply everywhere, and the laws of general relativity are supposed to fly everywhere. Well, you can't have two separate everywheres." In the same documentary, Greene analogizes the relationship between quantum mechanics and general relativity as two families that live under the same roof and cannot get along. Witten uses more violent language to describe the division. His use of the word "clash" (p. 24).

Even "murder" becomes a descriptive word to describe the division. Before the Green-Schwarz discovery, unification was understood to be impossible. Weinberg uses the term murder to describe the means by which there would need to be a revolution, which could allow unification to once again become a vision, a goal, a re-awakened pursuit of the holy grail of physics, "A paradox like a murder in a locked room may suggest its own solution, but a mere mystery forces us to look for clues beyond the problem itself" (p. 205). Of course, the re-birth of unification would eventually come about.

The tale of Albert Einstein being a hindrance to Theodore Kaluza is dramatized for observers. Kaluza's effort to publish a theory that breaks some of the division in physics. *The Elegant Universe* (McMaster, 2003) portrays a hypothetical one-sided conversation between Kaluza and Einstein as they sit across from one another in Einstein's office. Kaluza comes to Einstein and tries to talk to Einstein about a theory he had put together that solved some of the divisions in physics; yet Einstein ignores Kaluza. Kaluza then reads a letter that Einstein wrote back to him after he had sent his idea to Einstein, in which Einstein stated that the theory was interesting. Kaluza goes on to express his frustration with Einstein's lack of cooperation as Einstein continues to refuse to acknowledge his presence.

Another form of the distress rhetoric is in fear of the unknown because of the vast differences in theories. Driven by the complications in seeking to penetrate the role of gravity in quantum world, Halpern employs metaphors that describe our lack of understanding of the universe. We could come to know these kinds of forces if only we could realize that "this matter makes its presence known only through its gravitational influence" (p. 271). Yet because of this understanding, we are left to speculate about a universe that is scary, that intimidates. It is a "barrier" that is "impenetrable" (p. 271). And it is like the "Berlin Wall during the Cold War years" (p. 271). Our lack of understanding is so disturbing that it can "lead to shivers down one's spine" (p. 271).

The theme of distress brings forth various kinds of discourse, which are meant to unsettle the audience. Themes such as struggle, failure, plague, and battle work to create an ultimate emotional theme for the string theory audience. Indeed, as the division discourse intensifies in string theory discourse, the emotional response becomes more powerful, ultimately leading to shame.

Shame

Decades of distress from dealing with the frustration of division lead to what I call a rhetoric of shame in string theory discourse. String theorists gain leverage in convincing their readers by employing a rhetoric of shame. Further, they accentuate that shame by demonstrating that physicists have hid the secret of division from the wider public.

The discourse describing the division between established theories becomes more troubling, more descriptive of the division as repulsive. In some ways, we understand the language as becoming more violent in the shame theme. With his discussion of physicists' inability to solve the paradox of division, Halpern says that such lack of results lead to "embarrassment" (p. 11). Physicists eventually accepted the division, yet tried to suppress it. Halpern writes that these problems have caused scientists to "wield an axe" (p. 1). The reason for this metaphoric choice of weaponry leads to another metaphor that solves the problem: such scientists want to "sever" the problem from the common understanding of physics (p. 1).

That suppression of the exigency is why string theorists work to get vernacular audiences to understand the division. Creating shame in physics is essential to their successful persuasion of the vernacular audience. As a result, Brian Greene uses a metaphor of shame that captures the way scientists have been hiding the "dark secret" of physics (McMaster, 2003). Weinberg says that theories which do not fit together have caused "nonsense" in physics and many things have been "ruled out" (p. 237). Weinberg's choices of "nonsense" and "ruled out" show the desire of physicists to separate themselves from their problems, to put them in the past, and to let them go.

Terminology that emphasizes weakness gives a feeling of shame, such as Weinberg calling present theories "tentative" (p. 6). Such tentativeness comes through admitting "ill-formulated" attempts to break division took place, and explaining the tensions between a group of theories that do not coincide, and which Weinberg admits is a sort of "mishmash" (p. 192). "Mishmash" gives the impression of large disorganization, lack of order, a big mess that is unable to be fixed. Such lack of organization is embarrassing for advanced professional scientists.

Embarrassment also is accompanied with metaphors. Weinberg states that differences in theoretical foundations have lead to “distrust” over the past seventy-five years. Halpern also describes the suppression of division as a topic that was “forbidden” (p. 224). Halpern’s expression of embarrassment is more explicit in his description of the history of Einstein’s and other scientists’ attempt to unite theories that do not coincide. The section of the chapter has the enlarged, bolded heading “Thou Shalt Not Sin” (p. 171).

Metaphors of being unwilling to collaborate are also in the shame theme. Peat says that quantum mechanics and general relativity have “stubbornly refused” (p. 17). “Stubborn” brings a feeling of prideful unwillingness, of spite, of deviance from what should be, of what is orthodox. This metaphor personifies the theories and gives them a quality of being wrong in their present states. As a result, Peat writes that they cannot be “reconciled.” Such stubbornness leads to employing a metaphor that makes the two theories so deviant in their willingness to come together that they are “irreconcilable” (p. 17). Musser adds that this kind of irreconcilability has brought about “delayed gratification!” in physics (p. 19).

Some writers become more explicit in their dismay of the division and the shame it brings to physics, stating that there was “little hope” for physics because of the mess that physicists had worked themselves into by coming up with such polarized theories (Green, 1986, p. 48). In an observation at the time, journalist Mitchell Waldrop (1985) said that physicists had “failed dismally” (p. 1251).

And shame is expressed by some in the debate, namely opponents of string theory, as a failed attempt at providing a unifying theory. This attitude toward string theory lead to string theorists being cautious in their arguments. For example, to publish in the tradition of Kaluza-Klein was “Russian roulette” (Halpern, p. 291). And the string theorists share the same feeling of shame for those who have in the past refused the findings of string theory as the division-healer, calling those days “less-enlightened times” (Halpern, p. 291).

Shame is often admitted, yet pushed upon one theory or the other as the ultimate failure to solve the division. Both camps will admit a lack of cohesion, yet will put responsibility of the division on the other. Nonetheless, shame is a theme that must emerge in order for string theory to become the solution, regardless of which camp (quantum mechanics or general relativity) bears the greater blame. Schwarz (1987) writes that “elementary particle theorists have ignored the gravitational forces” (p. 33). Here Schwarz is putting the blame on particle theorists for lazily ignoring the established theories of general relativity. “Ignored” adds a sense of accusation, in which blame is placed on one camp. Glanz (1987) adds that “the strange rules of quantum mechanics are to blame” (p. 1969). And Duff (1998) adds that “general relativity fails to comply” (p. 64). “Fails to comply” assumes stubbornness on a camp that is unwilling to budge and adds to the problem of division through irresponsible carelessness. Duff then exclaims in frustration that the shame that both camps have caused the world of physics, stating that “Something big has to give. The predicament augurs less the bleak future of diminishing returns predicted by the millennial Jeremiahs and more another scientific revolution” (p. 64). Duff is making a bold exertion when he argues that one of the two theories has to give in. If they continue to be at odds with one another, one will have to succumb to the other's evidence. This language creates urgency in which, if the contradiction is not resolved, we will see the end of one of the two major paradigms of physics.

And the shame theme is also filled with arguments against the string theorists who entered the story of the progression of physics. Halpern quotes Sheldon Glashow's poem, in which he expresses his disdain and desire to get rid of the issues being raised by Witten, which support string theory,

> The Theory of Everything, if you dare to be bold,
> Might be something more than a string orbifold.
> While some of your leaders have got old and sclerotic,
> Not to be trusted alone with things heterotic,
> Please heed our advice that you too are not smitten—
> The Book is not finished, the last word is not Witten. (p. 256)

The shame becomes personified when John Schwarz recalls his being denied tenure at Princeton because of his faithful devotion to exploring the ideas of string theory. And the string theorists themselves express the theme of shame as they reflect upon the pain caused by those who hastily dismissed string theory. Susskind recalls that it left him "depressed," "saddened" and caused him to get "drunk" (McMaster, 2003).

Despite the despair, there is still hope. Adding wording that accentuates the pain of shame, Davies and Brown write that we must have a "reappraisal of commonsense ideas about the nature of matter" if physics is to go forward with progress(p. 18). Davies and Browns' calling for "commonsense" demonstrates the disdain, the embarrassment that accompanies a division in such advanced scientific ideas.

The reader comes to the point of wanting the solution to be presented soon. Convinced that physicists are hiding this “dark secret,” the consumer of string theory discourse is ready to be satisfied. The road to creating shame is gradual. First the reader or viewer must realize the difference between the two paradigms, then become uneasy with the idea and ultimately feel, as do the string theory writers themselves, a need to resolve the issue.

Conclusion

In this chapter I have demonstrated the importance of division in string theory by illustrating the process by which string theory advocates create a need for the new in their audiences. This is done by constructing the shameful world of physics. The guilt in physics has been established for vernacular audiences. In a Burkean sense, redemption is found in terms that create and establish a world of, in the tradition of White (1973), a history that is resolved via the employment of key rhetorical expressions that are repeated in a tradition of discourse, and which carry heavy power for the rhetors who use them.

Yet we are only beginning our journey in understanding how and why string theory discourse works at the public level. In conclusion of this chapter we must turn to a discussion of the popularization of new scientific ideas. Here at the intersection between the problem and the prescribed solutions by string theory proponents, we recognize that science succeeds or fails according to public perception of the theory. This issue has been important to philosophers of science.

Physicist Steven Weinberg (1992) writes that there are three places where science people discuss and deliberate about science. Specialized discourses in the mathematical sciences migrate into a public discussion of policy. The result is accumulation of funding for research and, at the heart of the string theory project, a newfound "public support" for the theory (Weinberg, p. ix). Science essayist F. David Peat (1988) describes how successful movements in science are accomplished as cultural shifts in thought, "It took generations for scientists to persuade the populace that Earth revolves around the Sun. A century and a half after Darwin's proposal, segments of the public remain unconvinced. One would hope that a final theory of the universe could be appreciated by all" (p. 292).

Public support for scientific theories require scientists to engage the artistic power of rhetorical invention in order to present new ideas as elegantly as possible. This is done through dramatic appeal. In string theory, it is accomplished through the romantic tale of heroism. A major element of this discourse involves the demonstration of a problem, in this case the lack of unity and the danger of division.

String theorists discuss division in physics in straightforward, summarized versions in which the reader can get a holistic understanding of how the history of physics has unfolded, along with an understanding of the common arguments that are used by critics to dismiss the theory. The story teaches the reader to be unsatisfied with the exigency of division in physics, showing that this dream must be brought back because the problems in physics are that important. For the reader, resolving this exigency becomes not something that physicists wanted in the past and yet gave up on, but something that is necessary, and is a vision which readers eventually desire to come to fruition.

The strategies of division in string theory prepare readers to be ready to enter the world of unification, to be promised a sort of millennial bliss in our understanding of the universe. In chapter four, I address this journey. Readers are prepared to be given a new reality, a reality which transcends bodily senses. Readers are ready to accept the claims they hear while on that journey because of the elegance of the claims, the *ethos* of the rhetoricians, and the enthymematic nature of the theories with theological premises. Unification and Theory of Everything offer the audience a reverential and sacred engagement with the abyss of the mysteries of nature. As elegant as the theory is on its own scientific terms, the rhetorical process of engaging readers in that journey is an important and reality-altering phenomenon.

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Chapter 4

Unification: The Holy Grail of Physics

As chapter 3 is an analysis of the rhetorical usages of division and therefore establishes that there is a symptom of distress in physics, I now turn to analyzing the solution that is offered by string theory proponents. The term unification is significant in physics. It is a state that physicists wish they could reach. If unification was to be reached there would no longer be blocks between the varying paradigms of physics. String theorists speak of this term with reverence. Their interest is in magnifying the importance of this term while also magnifying the problem of division. The result is a rhetorical effort to establish desperation for resolving this problem and finding the peaceful resolve of unification. Popularization, metaphors, creation of heroes, and the framing of the concept of unification into language of the vernacular, all allow unification to be tied to string theory, and therefore to anoint string theory as the sacred solution to division.

In this chapter I outline the significance and use of the term unification to establish string theory as the great unifying theory of physics. I begin with a discussion of unification as an abstract, Platonic dream of physics that cannot escape the usage of rhetoric. Then, I overview how unification is a sacred idea. I then break down how the translation of the notions of the sacred is the rhetorical invention of the efforts at persuasion. Connected to the importance of the invention of discourse of the sacred comes the importance of the romantic narrative. Central to that element of romantic narrative is the string theory emphasis on the Holy Grail question. Significant to the Holy Grail journey are the establishment of heroes. From this knowledge, string theory is presented as the unifying theory, in which unification is understood and appreciated at an everyday level for audiences of string theory discourse.

Unification: the Platonic dream of physics

Unification in physics refers to the bringing together of all theories under one banner theory that can account for how all theories can be understood in relation to each other. Different paradigms use different conceptual laws for describing the universe. As a result, the varying established laws of physics have never been explained at a more foundational, basic level of how all the laws fit together. Unification is, at least amongst physicists, the abstract yet put-on-the-shelf idea because of failed efforts, in which everything should be fit together through some kind of equation. Being unable to find a solution, this pursuit was set aside. String theorists resurrect this sacred dream and argue that they have found it. At the public level, the use of rhetorical strategies allows the term to be clearly understood by the public and to be an attractive dream to hope for.

In the pursuit of a dream that is captured in an abstract term of unification, we end up with, therefore, yet more elements of the Platonic pursuit in physics, which takes on Aristotelian forms. The usage of the term unification is the underlying principle, which allows string theory to be accepted as the final, millennial term in physics' history of fragmented paradigms. The concept of unification is abstract. Its proponents argue that within all the complex and varying mathematical equations, there must be something that allows scientists, and all of us who read about string theory for that matter, to transcend this challenge of division. The available means of persuasion that allow a transcendent

concept such as unification to succeed lies, like the presentation of division, within language where the term itself is the idol to which physicists reverence and respect.
As I describe in chapter 3, one of the foremost strategies of the string theory movement is inviting audiences into the discussions of physics. In particular concern for this project is the efforts to allow string theory to be understood as the Theory of Everything. The exigency of division allows rhetoric to carry the weight it does in providing the solution, "Rhetorical works belong to the class of things which obtain their character from the circumstances of the historic context in which they occur" (Bitzer, 1968, p. 3).

The word unification is the locus of this analysis. The use of this term is what empowers string theorists to make string theory to become the promising, heroic theme. Here I emphasize that key words carry a hefty amount of weight in their capacity to effect change. As Bitzer (1968) writes, "The verbal responses to the demands imposed by this situation are clearly as functional and necessary as the physical responses . . . with larger units of speech come more readily under the guidance of artistic principle and method" (p. 5). Unification serves this function in string theory discourse, as does Theory of Everything, which I discuss in chapter 5.

Unification: a sacred idea

The rhetorical phenomenon that is happening in the popularization of the string theory movement is a process of translation of the secular into the robes of the sacred. It happens at several levels. One is the translation from specialized laws of physics to the reader of popular science literature. But the other is a more ancient translation. It is the translation of the notions, the desires, and the need for unification which was and is present in theological values of the pursuit of union in the ancient church. These values have also been present since the inception of physics of the oft-spoken day Newton observed the falling apple and had his revelation of the reality of gravity. Yes, string theory does indeed have a particular theological ring to it. It is present in its push for unification and, as discussed later, the Theory of Everything.

Yet the successful presentation of such a sacred idea is grounded in a Platonic tradition of seeking a transcendent reality. Unification, like Plato's heaven, is unreachable without the proper tools. This is the challenge that string theorists face. Thus, in efforts to establish a rhetoric of sacredness, important terms are referenced. Unification is the transcendence that string theorists seek. It brings about a sense of purity and necessity. The more abstract the idea, such the term unification presents itself within; the more necessary it is to teach audiences to revere the term. This is done through the pulpit of scientific popularization.

This is not to say unification is the only concept translated from religious ideas into the scientific. Rather, I wish to emphasize that humanity feels the need to have something sacred in their lives. The depths of trying to connect to the mysteries of the unknown drive humanity into a search for meaning. Explanations for meaning of life, such as creation or becoming aware of extra dimensions, can provide closure regarding the mysterious abyss of transcendent notions of life that we wonder about. Hence the Platonic irony of wanting a transcendent reality (whether it be Heaven—Plato's argument—or extra dimensions) and yet not be able to share that knowledge without engaging in Aristotelian argumentation. In this case, the challenge of rhetorical invention and the choice to appeal to the sacred. As a result, ideas which are treated as important and conclusive by those we trust, such as scientists, bring us to valuing the prescribed ideas they share with us.

Being moved, or persuaded, by a metaphor such as the sacred scientific term unification is more than just the acceptance of words spoken by scientists, but can be understood as an experience with concepts in which we engage our whole selves on an intellectual, as well as an emotional level. We come to make commitments to the subject through our engagement of the literature. Effective persuasion stretches beyond just achieving internal cognition of presented arguments on the part of readers, but into deeper things. It goes deeper into notions we have had experience with, such as sacred things. Thus, the presentation of new ideas can be aesthetic experiences, particularly as the metaphor borrows from a more ancient metaphor. It can be an aesthetic experience for audiences who have always assumed a metaphysical reality. Believe in a reality that transcends earth—referring to heaven here—means the translation of these assumptions about reality can certainly fancy the minds of such belief-driven audiences.

There are various modes by which scientific discourse is sacred. One way is through ritual, as discussed in chapter 2 (Kreuziger, 1986; Blum, et al, 2006). The reverential use of unification to describe the significance of string theory makes the use of this term, I argue, a metaphor which allows string theory to come to mean what it does to readers of string theory.

Proponents of string theory use various analogies to show the need for a unifying theory. Strategies include methods such as analogies, which accentuate the incompatibility, and therefore the impossibility, of general relativity and quantum mechanics fitting together.

Thus, string theory constructs a sacred discourse as it spreads its promises of a peaceful, new age for physics, and by implication a holistic grasp on the universe. However, it is less in relation to this subfield of physics theological in its impetus, and more theological in its eventual proposed implications, as drawn by its advocates. It is not theologically sacred on the surface, but is appealing to audiences who do, in general, subscribe to theological ideas, are readily persuaded as the notions of sacredness present in discourse. String theory is presented to audiences who accept ideas of a universe which has audiences who generally assume a transcendent reality in one form or another.

Yet we must recognize that string theorists claim the theory offers the mathematical antidote to the problem of argumentation for the potential for unification. In other words, string theory is the link between mathematical rationality and the metaphoric, cultural dreams of unification—that age-old dream of science, at least as string theory proponents tell the story. String theory comes out of a series of mathematical formulations. It is the theorists themselves who give meaning to the formulations of extra dimensions and string particles. The mathematical formulations provide unification as the theorists apply them to the larger exigencies in physics. As the numeric formulation offers unification to the prevailing problems in the minds of physicists, the issue is simultaneously also brought to simple language in order to appeal to vernacular readers.

In this chapter I draw upon the tale of division among physicists that is told to readers of popular string theory discourse. The key to success for persuasion is in the constant discussion of this dream, which has been a focus of Western theology for two millennia. It is a process whereby scientists invent their rhetorical form through translating their greatest weapon, the term unification. As the term takes on the authoritative presence in science, the Platonic dream of transcendence remains grounded in Aristotelian argumentation.

What string theory offers common readers of science literature, then, is a way to transcend the contradictions of quantum mechanics and general relativity. The string theory literature is careful to illuminate these dichotomized paradigms of physics in order to show the reader the need for string theory to be continually pursued and supported. The world of physics, then, emerged at the mercy of the constructed world of utopianism present in religion as a mode of thought, which physicists inherit, being that it had to be described via the medium of language—which was so long associated with theological understandings of the universe. String theory is, then, in its efforts to provide such unification, a reworking of previously present (perhaps ever-present) human symbols in any great narrative. In this situation as like so many others, it is about the mysteries of the universe.

The need to popularize

Sacred things are shared. They are given to audiences who appreciate and will support the idea that is offered to them. To make things sacred on a larger level, the preacher of the sacred idea must be a careful and strategic campaigner. As unification is a scientifically sacred dream, audiences are given this knowledge with careful packaging. String theory proponents tell the story of unification in physics (and science in general) being on the quest for a Holy Grail. The story goes as follows. The laws of physics were being discovered, and at the same time zealous theorists were finding ways to unify them.

It was an exciting time when quantum mechanics was emerging and eventually united together with electromagnetism. Einstein was discovering the relativity of space and finding a way to unite it with gravity. This tradition of unification in physics is the first topic Brian Greene discusses in the film *The Elegant Universe* (McMaster, 2003), with particular attention given to Albert Einstein's fascination with unification. Musser (2008) adds to Greene's history of Einstein, writing that "Einstein himself worked on his version of a unified theory for the last third of his life. Talk about delayed gratification!" (p. 19). Both Greene and Musser stress at every level of their works the popularization of string theory.

Part of the challenge of rhetorical invention in the string theory movement is in finding ways that string theory can be established as the unifier. A significant element of that process is in finding ways in which the theory can be distributed at maximum distribution. This is where translation from technicality must be brought to the vernacular level is practical. As unification is easily understood at the public level, the enthymemes of the sacred in linguistic form attract audiences to the cultural elements of reverence for an unobservable transcendent reality is appealing.

Inventing the sacred, translating the ancient

To create a sense of sacredness which audiences will appreciate and subscribe to, it is essential to tell great stories. And at the heart of any canonical story in which reverence becomes a characteristic which audiences employ, it is necessary to employ language of intense battles of good triumphing and of great endurance in order to bring peace. Such happens in the sacred-wrapping of string theory around the millennial notion of unification.

To capture the essence of unification in physics as a sacred narrative, which audiences learn to revere, I refer to Steven Weinberg (1992), an accomplished particle physicist who is optimistic about string theory. Weinberg lists all the laws of physics which were known at the time of the twentieth century. Weinberg cites a cynic-turned-supporter of the pursuit of unification, University of Chicago, Nobel Prize winning experimental physicist Albert Michelson. Weinberg paraphrases Michelson,

> Already in 1902, the previously complacent Michelson could exclaim: 'The day appears not far distant when the converging lines from many apparently remote regions of thought will meet on . . . common ground. Then the nature of the atoms, and the forces called into play in their chemical union; the interactions between these atoms and the non-differentiated ether as manifested in the phenomenon of light and electricity; the structures of the molecules and molecular systems, of which the atoms are the units; the explanation of cohesion, elasticity, and gravitation—all these will be marshaled into a single and compact body of scientific knowledge.' (p. 15)

The Platonic strains of an abstract reality, present in this quote as a hopeful millennial reality in the future allows audiences to enter the mindset of embracing the notion of unification as the solution. I emphasize the term notion because the rhetorical power of this term is the reverence to the idea of unification. It is a notion that gains importance as audiences come to understand unification, embrace it, and have a hope for it in the future.

The challenge of establishing unification has to do with realizing the available means for establishing string theory as the answer. This is an effort for invention. Establishing string theory as the unifier requires that language be employed. In the efforts to frame it as the unifier, behaviors or reference emerge in the rhetoric of string theory. Choices to reference the term unification allow a process of translation to transpire. The translation is the mindset of sacred reverence. It is then transferred to the audience via the example set by the rhetors for audience to then embrace.

But why does unification, the very term itself, create such promise for physicists? The key reason is that it provides the antidote to division. Yet the rhetoric of division that is used by string theorists is part of the systematic structure that allows unification to be the trope that solves the challenges that permeate our understandings of the laws of physics. Effective use of unification comes through addressing the value systems of audiences, and then shaping the prescribed idea (string theory as the ultimate law of physics) into language which appeals to audiences. In other words, the language of the rhetor must connect to and successfully engage the values of the audience.

Proponents of string theory work to persuade the broader audience, which is, due to lack scientific training, more susceptible to scientific argument than knowledgeable physicists. String theorists tap into enthymemes in their efforts to persuade general audiences who do not have specialized scientific knowledge. The significance of the term unification emerges out of the contradiction between the theories of general relativity and quantum mechanics, leaving us facing a contradiction of an unordered, chaotic, and messy universe. String theory offers us a solution to the chaos. In popular string theory discourse, string theorists give their audiences not something which is a mess, but is, in the words of Brian Greene (McMaster, 2003) “elegant.”

String theory writers tap into enthymemes of the sacred, which I argue are part of the value system of contemporary culture. This is found in the capacity for translation to take place as technical concepts are made available for a public understanding. It is a translation that takes place in the minds of the rhetor and in the minds of the audience. The rhetor does the work of knowing and drawing upon historical beliefs of the audience, as the audience then attaches meaning to the new idea because it is connected to previously held assumptions and values. This is not a simple process which is strategically accomplished, but is the result of the complicated process of translation.

Much of this argument has to do with the concept of unification being an enthymeme in cultures that have notions of sacredness. I argue that unification is a historically theological principle, which comes in various forms—‘become one with God,’ ‘love thy neighbor’—and to therefore succeed in this sense, “Speeches using paradigms are less persuasive, but those with enthymemes excite more favorable audience reaction” (Aristotle, p. 41). Invention in popular string theory discourse has as much to do with inventing history and heroes in the movement as it does with describing the theory itself.

Romancing the Holy Grail

Introducing an exotic new idea about the universe and coupling it with the peaceful promise of unification can be hypnotic for audiences. Part of that hypnotic power is in a rhetorical strategy of showing a theme that emerges repeatedly. This makes the idea’s emergence seem inevitable. It appears natural. In this way, ideas are capable of being re-born in scientific discourse. This suggests to readers the inevitability and therefore valid nature of the claim the scientist is presenting to the public. Raphael Bousso and Joseph Palchinski (2004, September) capture the essence of the dream of unification and how string theory meets those needs, not just in the dreams of physicists, but for our collective understanding of reality. All of these qualities are coupled with the promise of a romanticized story of nature emerging victorious as it offers humanity its true form. It is a story of humanity's romanticized experience of receiving revelation from nature,

> The search for a unified theory is a central activity in theoretical physics today, and just as Einstein foresaw, geometric concepts play a key role. The Kaluza-Klein idea has been resurrected and extended as a feature of string theory, a promising framework for the unification of quantum mechanics, general relativity and particle physics. In both the Kaluza-Klein conjecture and string theory, the laws of physics that we see are controlled by the shape and size of additional microscopic dimensions. What determines this shape? Recent experimental and theoretical developments suggest a striking and controversial answer that greatly alters our picture of the universe. (p. 78)

Bousso and Palchinski provide a thorough list in the history of physics where unification has been inevitable, where it is fate. While Bousso and Palchinski do not explicitly tell their magazine readers that unification is fate, their argument is part of a larger system of string theory proponents leading audiences to the significance, fate, and need for unification.

The key challenge in this romantic narrative is the task string theorists face in unifying two theories that have been experimentally supported. At the realization that gravity cannot operate at the level of quantum mechanics, the dream of unification of physics died out, at least until the Green-Schwarz discovery. Steven Weinberg (1992) calls this the "Twentieth Century Blues" (p. 191). Theorists had given up on unifying the laws of physics because it was impossible to unite quantum mechanics and general relativity because the universe had been understood as a four-dimensional universe. In fact, the laws of quantum mechanics and general relativity had been so convincingly proven that unification was generally understood as impossible.

The disparaging comments of lost visions of unification lead to the vilification of those who continued to pursue unification. The theories of quantum mechanics and general relativity were concrete, "For over fifteen years the hierarchy problem has been the worst bone of theoretical physics. Much of the theoretical speculation of recent years has been driven by the need to solve this problem" (Weinberg, p. 205).

But at the time, pursuing unification became a joke, no longer a realistic vision to pursue. It became so impossible that it "seems to enrage some philosophers and scientists. One is likely to be accused of something awful, like reductionism, or even physics imperialism" with such grandiose claims (p. 18). And although the Green-Schwarz discovery convinced many to see string theory as a great unifier, it was not conclusive. Many still doubted, but saw its potential.

The pursuit of unification in the string theory movement is often called the 'Holy Grail of Physics.' This phrase captures the beauty and elegance of the efforts of string theorists to present string theory as the great unifier of the laws of physics. This metaphor shows how sacred the idea is in the minds of theorists.

The evocative symbol “unification” prepares audiences for a conception that may convincingly become the Theory of Everything. Here I examine the strategies used by journalists, physicists, and film producers to frame “unification” as a term audiences ought to revere. For example, physicist-turned-science journalist Mitchell Waldrop (1985) shares his excitement about string theory as the unifier of physics in his *Science* article, “Most important of all, the superstring model at last seems to give the physicists their Holy Grail a finite quantum theory of gravity” (p. 1251). The importance of providing unification is similarly expressed in popular string theory discourse as essential to the future of physics. F. David Peat (1988) stresses how important the dream of unification is in scientific history,

> Throughout its history—which is a relatively short one when compared with other great human endeavors such as art, music, drama, poetry, and philosophy—science has pursued a Holy Grail called unification. The great scientific minds have always been concerned with discovering a unifying pattern to phenomena and bringing ideas together within the compass of a single insight. (p. 71)

Despite not being a string theorist himself, Weinberg saw the potential for the theory to find a way to unify. Note that Weinberg’s optimism was present before the 1995 Edward Witten discovery of unifying the various forms of string theory. Being known as a key unifier in the history of physics himself as he is a Nobel laureate for his work, which combines the weak force and electromagnetism. Considering the date of his 1992 book Weinberg shows great confidence, despite how his faith was in the potential for string theory to bring about unification, despite how string theory itself did not yet have a unified explanation itself! This is because five different string theories emerged after the Green-Schwarz discovery. In the words of Weinberg, "String theories therefore potentially represent a major step toward a rational explanation of nature. They may also be the richest mathematically consistent theories compatible with the principles of quantum mechanics and in particular the only such theories that incorporate anything like gravitation" (p. 218). The romantic clan of string theorists had to come together as a team and unify themselves, before they could take on the dragon of offering an all-encompassing unifying equation.

The language of despair in the face of general relativity and quantum mechanics being irreconcilable is met with the morning of promise of the re-birth of unification, demonstrated in the recognition of the Green-Schwarz discovery. After a detailed history of the historical efforts of physicists to unite science, F. David Peat (1988) concludes his discussion on how, while many theories had been united, the dream of finding a grand theory for all other theories of physics had run dry. Peat's language captures the epic nature of string theory as the great unifier. He finishes his chapter long treatment of those dark days of lost dreams of unification, which followed great moments of unification with reference to the significant event of the Green-Schwarz discovery of 1984, "By the early 1980s physicists were discontented. Matters had not gone as well as they had hoped. The initial excitement of the grand unification approach had worn off. What was needed was some dramatic new idea, a move in a totally new direction. In 1984 that direction was signposted. Its name was superstrings" (p. 95).

A final form of the romantic story of achieving unification is in description of the significance of timing between the beginnings of physics theories fragmenting into various paradigms. Musser begins his initial discussion of unification in his book *The Complete Idiot's Guide to String Theory* with bolded, enlarged lettering: "Theories of the World, Unite!" (p. 87). Musser then moves on to make the theories of physics come alive with his history of how unification has been and will be the ultimate fate of all theories.

One law of physics is born just before the other, as if general relativity and quantum mechanics had to be offered as the precursor theoretical understandings, which would pave the way for string theory, "The general theory of relativity was not even a year old and quantum theory was still in its birth throes when Albert Einstein recognized that the two theories would have to be reconciled" (p. 87). This method of personifying the theories functions to give a reverential, human sort of perspective on the theory and the theories it works to unity. Consistent repetition of nature revealing itself romanticizing the history of string theory in a blanket of holy narratives, in which rhetorical invention is demonstrated in the Platonian efforts to transcend by drawing upon modes of thought that have permeated the mind of the Western world for centuries.

The rhetoric of the Holy Grail story in unification helps the reader to see unification as a natural process. Several lessons are passed on to the reader. One is that nature inherently, perhaps even *desires,* to be unified. By implication, string theorists are in tune with nature. Another is that grand unification is inevitable, and string theory has impressively achieved unification in the most difficult unification effort in history: combining general relativity and quantum mechanics. In the end, rhetoric of re-birth deems string theory worthy of acceptance.

Saviors of physics

Romantic tales are not good stories without the presence of heroes. The Holy Grail is not discovered without a group of dedicated knights. Another theme in science narratives that involves selling unification to readers is framing its scientists as heroic. This dream is captured in the edited book volume featuring several physicists, *Unification of Fundamental Forces* (Salam, 1990). In it physicist John C. Taylor (1990) writes, “From time to time, science succeeds in unifying apparently diverse sets of phenomena. These unifications provide some of the most impressive achievements in the sciences” (p. vii). Taylor then discusses key physicists who pursued this dream. For example, Isaac Newton was obsessed with putting together all theoretical ideas as he sought to unite the “terrestrial forces” that makes apples fall off trees, and “celestial gravities” that makes planets orbit around the sun (Salam, p. 9).

Reaching even further back than the days of Newton, unification is presented as a theme employed by Galileo. Galileo sought to unify all laws of nature by fitting lots of ideas into what he called the “Galilean Symmetry” (p. 8). As the theories of electricity and magnetism emerged, physicists then worked to unite these forces, thus discovering electro-magnetism (pp. 10-12). Taylor then tells of other epiphanies which lead to unification. Realizing that electromagnetism was not united with the theory of optics, physicist Heinrich Hertz produced electromagnetic radiation, which unified these two forces. After telling the history of scientists being focused on unification, Salem turns to the most famous physicist who sought unification. The young Albert Einstein became concerned with the contradiction of light and gravity, arguing that gravity could not possible move faster than light, and he was able to unify space and time with his theory of general relativity. Peat (1988) spends an entire chapter telling the same history.

The presentation of key scientists as unifiers allows the reader to put the importance of unification into perspective. It is understood as one of the key themes that signals great scientific research. It is understood that, in the minds of these scientists, the noblest of scientific discovery. Even more than discussing it, visualizing such heroic tales shows readers the importance of the effort to unify. Consider the visualization to compare great moments of unification. In Musser's (2008) book he charts the history of unification in physics, drawing it back all the way to Aristotle (p. 18),

Great Unifications in Physics

Year	Unifier(s)	Theory	What it Unified
4th century B.C.	Aristotle	Aristotelian natural philosophy	Matter, change, motion, and cause
1686-1687	Isaac Newton	Laws of motion and gravitation	Celestial and terrestrial motion
1861	James Clerk Maxwell	Electromagnetism	Electricity, magnetism, and light
1869	Dmitri Mendeleev	Periodic table	Chemistry
1905	Albert Einstein	Special theory of relativity	Electromagnetism and laws of motion
1915	Albert Einstein	General theory of relativity	Special relativity and gravitation
1900s-1920s	Neils Bohr, Werner Heisenberg, Erwin Schrodinger, and many others	Quantum mechanics	Electromagnetism and atomic theory of matter
1920s-1940s	Paul Dirac, Richard Feynman, and many others	Quantum field theory	Special relativity and quantum mechanics
1960s-1970s	Abdus Salam, Sheldon Glashow, Steven Weinberg, and many other	Electroweak theory	Electromagnetism and weak nuclear force

An important part of this chart is Musser's careful focus on the chronological structure of unification. As a central part of the Holy Grail quest type of narrative, it becomes clear in this chart that the role of heroes is a natural part of history, a natural result of scientific discovery. Emerging out of the puzzle of the sacred enthymematic tendencies toward heroism, the romantic tale that is translated from sacred narratives into the story theory story results from the enthymeme of the sacred being innately grounded upon the notion of heroism. In essence, as string theorists reverence unification, they take on a form of sacredness in their discourse. That sacredness is enthymematic of the audience. And within that enthymeme lies the romantic journey, the noble fight. At the center of that narrative is the absolute necessity of heroes. Thus, in the transference of enthymemes via translation because of rhetors' efforts to appeal to audiences, the hero theme never escapes the story.

This is executed most clearly as string theory proponents draw vivid images of heroes for the cause of unification. The beginning of *The Elegant Universe* (McMaster, 2003) documentary shows Brian Greene outside of Albert Einstein's Princeton, New Jersey home. Greene steps out of the front door and describes Einstein's anxious efforts to unify the laws of physics. Greene concludes his story of Einstein by stating, with somber music playing, the dream of unification died, along with Einstein, in 1955.

Before diving deeply into his twenty-minute explanation of Einstein which he discusses later, Brian Greene discusses Isaac Newton's experience of watching an apple falling from a tree, and that Newton was able to unify the heavens and the earth in a concept he called gravity. Greene states, "In one fell swoop, Newton unified the heavens and the earth in a theory he called gravity." As we watch the film we then hear the voice of acclaimed particle physicist Steven Weinberg state, in his typical elegance, "The unification of the celestial with the telestial, that the same laws that govern the planet in their motions govern the tides and the falling of fruit here on earth. It was a fantastic unification of our picture of nature" (McMaster, 2003).

We also see the demonstration of cohesion among the science heroes themselves. Contemporary proponents of this provocative theory are famous to a degree, namely Brian Greene, Lisa Randall, Michael Green, John Schwarz, Edward Witten, Alan Guth, Burt Ovrut, and Michio Kaku, among many others. They are few in comparison to the larger community of physicists. These believers in string theory support each other and work to situate themselves into public discussion in which they compliment one another's ideas, therefore not only popularizing each other, but also their new theory. This is particularly evident in the films *The Elegant Universe* and *Parallel Universes,* where these scholars are interviewed and demonstrate their charisma and knowledge in media environments that create excitement for string theory. These figures become the brave, prophetic leaders of the new universe that is being taught via the borrowing, the translating of concepts from more primitive pursuits of unification. Part of the persuasive power of string theory to be understood as the one to bring unification is to show that the theorists are *themselves* unified.

The Green-Schwarz discovery cannot be overestimated in establishing string theory on the legitimate ground, with which it is finding its footing. Certainly, there are no science heroes in the string theory story more recognized than Michael Green and John Schwarz. A year after the 1984 Green-Schwarz discovery, Edward Witten described the magnitude of this most significant discovery in physics to *Physics Today* (1985), stating that string theory will now be difficult to defeat, thanks to the two thinkers who found the mathematical proof,

> Witten now believes that superstring theory 'will dominate the next half century, just as quantum field theory has dominated the previous half century' . . . Witten reminds us that physics has historically played a large role in the development of mathematics. 'We are now entering a similar episode,' he suggests. Superstring theory, having already pointed out extraordinary connections between previously unrelated branches of mathematics, will, he predicts, 'exert a profound and far-reaching influence on the future of mathematics.' (p. 20)

Witten tells readers that because of the discovery we are now on an unalterable path in the progression of physics research. We can no longer deny the possibility of strings and multiple dimensions. Readers come to understand this. As this grand discovery is weighed against the daunting task of unifying general relativity and quantum mechanics, readers are ready to join the brave scientists who are helping the audience to become familiar with the inevitable and necessary task of unification. Important to that persuasion is the situating of key physicists who use, value, and understand how to use that term in the right ways, and to situate scientists as heroes for the cause of unification.

Unification and everyday life

From a romantic tale in which heroes have been established and are interested in meeting the needs of the people, string theory and its proponents offer truth for the audiences. Part of the success of this strategy is that the promise of the theory moves from a public discussion and becomes applicable, hopeful, an idea that earns the faith of audiences. In other words, unification becomes an idea that rests at the everyday, personal level for audiences. The execution of this move is demonstrated within the string theory discourse. *The Elegant Universe* (McMaster, 2003) begins with Brian Greene attempting to teach advanced physics to a black lab. He tries to connect with the dog on a complex scientific level, and after several moments of frustration, Greene gives up on trying to help the dog understand advanced physics. All the mathematical equations on the blackboard then disappear and the word unification appears on the blackboard in all capital letters. This attempt to explain advanced physics to a dog allows Greene to then describe for viewers which, while not simple, human beings are indeed capable of understanding the vision of unification in physics.

This demonstration of explaining unification at a basic level sets up the way with which string theory appeals unification to the audience in a third way: the idea of unification is so important, so necessary to be understood, that it should be presented so simply that perhaps even a dog would grasp the idea. The implication of this act is the continual translation of the theory at more and more basic levels. As translation continues, talking on more basic forms and being armored with religious symbolism in the process, it becomes clear that the rhetoric of unification is, for string theorists, of the essence.

The dog scenario brings the concept of unification home; it personalizes unification for the reader. As readers engage string theory as the grand unifying theory, the universe becomes complete for them as they connect the ideas to their previous notions of reality. As we realize that all Greene is really getting at in his attempt to teach advanced physics to a dog, perhaps there will be no reservations of a unified theory on the part of readers. This means the laws of nature will be complete in every way, “It may well entail a full unification of all the phenomena known to humans, in which case it will be the first theory without fine print, such as ‘use only for small particles’ or ‘don’t apply at such-and-such a time’ (Musser, p. 19). An article reviewing McMaster’s *The Elegant Universe* compares the theory to music, a symphony of an experience for audiences of string theory,

> Recently, some physicists have proposed that the road to Einstein's goal does not lie in trying to unify the bestiary of point-like particles. Instead, they suggest that the building blocks of matter are tiny vibrating strings of energy. Like cello strings that can sound multiple musical notes, strings exhibit different particle properties depending on how they oscillate. By the end of the first episode, Greene has galloped over huge expanses of physics, helping us understand what the search for unification means and hinting at why strings may be the solution. (Voss, 2003, October 24, p. 570)

Here we could move to engaging a rhetorical theory of aesthetics in regards to life. But the point is that part of the reason we engage in art is because it offers closure through aesthetic beauty. The rhetorical strategies used by string theory proponents, and especially in the use of unification, function like a symphony in the lives of audiences who learn about string theory. The significance of the strategies is captured by the reverence toward this Platonic sort of transcendent existence, all of which is enthymematic as transference from the technical to the vernacular via the robes of sacred rhetorical choices on the part of the rhetors.

In order for persuasion to be accomplished, the proposed idea must be appealing, artistic, and connected to parts of life which are personally motivating. This explains why string theory is communicated on a vernacular level: it can answer questions about the universe for everyone who becomes its proponents, and not just scientists. In a *Scientific America* interview with Brian Greene, George Musser (2003) states:

> String theory used to get everyone all tied up in knots. Even its practitioners fretted about how complicated it was, while other physicists mocked its lack of experimental predictions. The rest of the world was largely oblivious. Scientists could scarcely communicate just why string theory was so exciting--why it could fulfill Albert Einstein's dream of the ultimate unified theory, how it could give insight into such deep questions as why the universe exists at all. (p. 68)

As humanity asks deep questions on many levels—theologically, philosophically, and especially astronomically—string theory is framed to be a unifier which will lead us to answers regarding such timeless questions that are part of the human experience.

Here I wish to return to an emphasis on the power of language. Certainly, no scientific theory could become so personally gratifying for readers without a toolset of rhetorical terms that carry a heavy punch—a punch to the heart of readers. To do so, I will bring Kenneth Burke back into the discussion. Yet, as discussed in chapter 3, the two paradigms of general relativity and quantum mechanics house the larger body of physicists. Both paradigms are backed with extensive laboratory evidence. Thus, although the string theory movement promises unification, as this new paradigm requires a reworking of the assumptions of the previous two traditions, the resistance to changing such well established theories has kept string theory advocates being comprised of a relatively small number of physicists, particularly as string theory lacks the empirical backing that the two previous paradigms possess.

Hence, string theory's appeal to authority, to offering union, is found in, as described in the next sections, the Burkean attempts to authorize language as authoritative and to target the non-scientific audience that is ready to consume scientific knowledge, particularly scientific knowledge that has a ring to it that taps into the nature of their belief systems. The attempt at authority, which is the ultimate goal of triumph over the two previous paradigms, is found in the constant push for unification.

As audiences of string theory rhetoric, we come to understand that quantum mechanics and general relativity cannot co-exist. String theorists face the same challenges to being authoritative for their audience as do leaders and teachers of religious faith. String theory certainly borrows, in its theoretical backdrop, from the empirical as it exists within the world of physics. Similar to religious rhetoric that seeks to connect humanity to a higher existence, string theorists promise, through the use of sacred language, a new understanding of the universe. What this means for the readers of popular string theory literature is that this new theory for understanding the universe has the same underlying assumptions about reality that have been assumed for millennia. The change is that they are now in a new form; they have been translated from other notions of sacredness. It is this translation of the sacred that makes string theory so personal, and therefore so potentially persuasive.

Several things are going on with the string theory language, which can be understood by tapping into Burke's ideas on the rhetoric of religion. Burke says that as rhetors seeks to explain the non-empirical; they borrow from the same sets of metaphors used by the language that describes the empirical. String theory borrows from theological discourse not by intention, but because of the nature of language. I wish to express here that it is not either-or. The reasoning of appeal to the sacred pre-dated the empirical observation in this instance. The mathematical reasoning was discovered before any empirical evidence supported notion of string particles as and other dimensions. This default use of sacred language to convince audiences is placed, by proponents, in opposition to, say, Isaac Newton's observing an apple fall from a tree and then theorizing gravity.

We recognize that the inherent theological and therefore personal nature of physics seeking such grand unification existed long before the string theorists began offering string theory as the antidote to the ills that physicists face. This third strategy of persuasion through personalizing unification is the employment of rhetorical invention of the first two strategies discussed in this chapter: the sacred romance and the presentation of heroes. In order to create a personally persuasive science for readers which appeals, string theory discourse must be richly historical. Its ideas must be invented, created in history. This is how we get to unification being seen as inevitable, and therefore is our destiny. It becomes truly personal as it addresses our notions of what constitutes the cosmos.

Conclusion

String theory pushes for a fresh paradigm. String theorists continue to translate its audience's faith in unification, whether it be historical attempts at unification in re-birth, praising scientists, and appealing these strategies to common understandings of life in its attempts to unify, to provide answers to what was previously unanswerable in the world of physics. In the popularization of the theory, the potential for unification is dependent, first, upon emphasizing the differences between general relativity and quantum mechanics in order to show itself as the great healer of the laceration between the laws of physics. Key elements of persuasion are, then, dependent on inventing histories and scientists.

There are various elements weighing in on the emergence of the popularization of string theory as its proponents seek the means of invention in the effort to offer a new understanding of the universe. This is done by translating forms of argument used by other, older discourses. One site for such inventional persuasion is the emphasis of the historical competition between general relativity and quantum mechanics. This tension is the most foundational of popular string theory discourse being able to unify. This division is what string theorists base their arguments for legitimacy on not only in the world of physics, but especially in proving to the non-scientific audience that it is significant, and more importantly, essential for the progress of physics. In other words, general relativity and quantum mechanics flourish as unification is downplayed, yet are shown to be lacking as the need for unification is magnified.

Therefore, great attention is given to the historical clash between general relativity and quantum mechanics in string theory discourse. While the contradictions of general relativity and quantum mechanics are ignored by these two camps within the world of physics, it is illuminated in popular string theory discourse.

In the popularization of string theory, both established theories are simplified, as is string theory itself. So if the messianic, unifying nature of string theory is presented as emerging from the darkness to redeem and satisfy the need for unification, then the lack of unification between general relativity and quantum mechanics is the exigency that drives string theory needing to be given to us by the ever-desiring to show itself to humanity, laws of nature.

We learn from Kenneth Burke (1970) that to attempt to reason in the pursuit of authority or to make statements about the non-empirical is to always employ metaphors. Metaphors attempt to fit thought and the natural world together through language. There is always a borrowing taking place as one seeks to transcend the natural world. While the concept of any potential truth that defies the natural world is perhaps presented as a novel idea in a given movement (a new scientific theory, a new religion), the capacity to express and share that idea with others, or more importantly to get others to subscribe to it and believe in its tenants, is to engage in metaphor, to borrow from language that was before used to describe other sorts of knowledge. Therefore, the transference from being persuaded to believe that there is a reality which transcends the natural world is a logical one that is based on scientific reasoning. It is an argumentative notion that must resort to explanation and is therefore incapable of not using language, and therefore cannot avoid borrowing from other discourses. In other words, it cannot avoid translation in attempts for invention. Ideas do not truly have a complete, original invention. As string theorists construct a rhetoric of unification, their attempts at invention lead to, as do so many other things, the translation of the sacred into new discourses that are driven by new motives.

Hence the Platonic notion of pursuing a transcendent reality cannot be shared with audience without the employment of rhetoric. While differing from Aristotle in what rhetoric was and what its purpose should be, Plato couldn't avoid engaging in, among other Aristotilian functions of rhetoric, the act of invention. And as invention is the act of finding the right words to say, the language of transcendence is the language of borrowing from the sacred.

Religion has been able to serve this kind of unifying function. Full of language designed to promise rewards to audiences, religion comes to play an important role in the success of, the rhetoric of, unification. Part of this phenomenon is understood as we examine in the evolution of scientific thinking, considering that we are discussing the sacredness of this theme in science. If science is the result of natural philosophy being fragmented, we must understand natural philosophy as related to concepts of the sacred, or as the proposed answer to theology. Therefore, as theology pre-dated science, it had priority on using the language that would shape the reality of knowledge. In particular, it had before it the means available to help humanity transcend its base, earthly circumstances. In other words, terminology of the sacred was at the disposal of science in past centuries, and especially for string theorists today.

Preparing for a Theory of Everything

The rhetoric of unification leads to a rhetoric of a Theory of Everything. University of Maryland Physicist James Gates gets at the heart of the string theory unification of the laws of physics, or the way for a rhetoric of unification. His perspective is an appropriate transition to where we go in the next chapter. He asks, “Why did Einstein want to unify? To know the mind of God, which means to understand the entire picture” (McMaster, 2003). The implications of ideas such as the potential for the existence of God, transcendence, and the role of humanity in the universe are what empower, enable, and give credence in the minds as to audiences of why it is significant that string theory offers unification and is therefore, as discussed in the next chapter, the Theory of Everything.

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Chapter 5

The Secular Sacredness of a Theory of Everything

Unification is the predecessor to the Theory of Everything. String theorists speak of unification as a great achievement, but the larger, more complete theoretical understanding is in how the unifying theory provides an all-encompassing theory. Physicists call this the Theory of Everything. They even give this vision an acronym: the T.O.E. Such a universal acronym in physics demonstrates how widely understood, vigorously pursued, and important the goal of finding a Theory of Everything truly is.

I now move to the final analysis chapter of this project with Theory of Everything as the subject of discussion because, as it is the theory which unifies, it becomes the ultimate theory, meaning the ultimate destination of physics. It will be the theory which is recognized, is revered, and is the new standard by which all physics research, as well as the persuasive endeavors, by which in this branch of science is accomplished. Theory of Everything is more crucial than unification, and comes after unification is achieved in the order string theory is presented in literature and film.

Theory of Everything is the last thing discussed. It comes with language that takes on a more religiously explicit form than other elements of string theory discourse. In this chapter I argue that Theory of Everything, as the climatic element in string theory discourse, takes on a more explicit religious form, result in a rhetoric of secular salvation. This pattern is consistent in string theory rhetoric. In Musser's (2008) book he discusses a final theory after proving string theory as the great unifier. Halpern's (2004) book does the same. Weinberg (1992) discusses Theory of Everything only in his last two chapters after discussing unification with the chapters being titled “Facing Finality” (p. 230) and “What About God?” (p. 241). *The Elegant Universe* also reserves discussing Theory of Everything until it is established that string theory is the final theory because it has provided unification. Further, the language discussed in this chapter are similarly extracted out of popular science articles, which are dominantly focused on the title Theory of Everything, such as Waldrop’s (1985) article “Strings as a Theory of Everything,” Taubes’ (1999, July 23) article “String Theorists Find a Rosetta Stone” and Witten’s (1985) anthology chapter “Superstrings: A Theory of Everything?” In this chapter I examine the language and arguments that are unique to the Theory of Everything discussions.

In this analysis I focus on passages in string theory rhetoric that surround the phrase Theory of Everything. As I describe in chapter 4, most books, articles, and documentaries have specific discussions about unification. Also in these texts are specific sections for Theory of Everything, which follow presentations of unification. The discourse I analyze here is specific to the concept of Theory of Everything in the string theory story.

At this point it is important to describe the difference between unification and Theory of Everything in regards to their function in string theory rhetoric. Unification operates as a verb in the string theory movement. Yet the Theory of Everything is a noun with special meaning, even more special than unification. If unification is the event of the millennial peace beginning, we can understand Theory of Everything as the reining, savior theory. Unification is the verb, or the act leads us to the noun, or to our destination. Unification is the path to the ultimate destiny of a Theory of Everything.

Theory of Everything takes on an apocalyptic tone, which takes audiences through the travail of a theoretical Armageddon and, ultimately, to a millennial setting, where physicists reverence string theory as the Theory of Everything. The story goes as follows. First, string theorists exercise faith in the theory as a concluding theory, and therefore encourage audiences to do the same. Faith leads to appreciating and heeding the words of prophetic forms of promise for the theory of everything. Third, we enter a stage in the discourse of theoretical Armageddon, which intensifies the challenges string theorists face in their field. Finally, string theory brings about millennial peace. Also, never in other elements of string theory is there such explicit religious metaphors. They are mythic-romantic like the moments of division and unification, but they become more religious here. Therefore, this is how we get to the secular salvation.

Importance of the Theory of Everything

The labeling of string theory as the Theory of Everything was coined decades ago by physicist John Ellis, who "invented the term in response to critics who had called string theory a 'theory of nothing'" (Dine, 2007, December, p. 37). Before that time there was a tradition that had lasted ages for scientists to discover the "final theory," which can be drawn back to being a dream that even Aristotle pursued and was at the forefront of Isaac Newton's experimental efforts (McCutcheon, 2010, p. 17).The Theory of Everything has been such a prominent dream in physics that it has earned the prominence of being titled with capital letters, "Theory of Everything" (Davies & Brown, p. 3). The appeal of the term gives science writers a powerful phrase to use in their presentation of string theory to audiences.

What is the work that is required in making a Theory of Everything and what does it mean in regards to the division of quantum mechanics and general relativity? Science journalist Gary Taubes (1986) writes, “To write a T.O.E., physicists have to interweave the mathematics of gravity with that of their other theories by explaining the force in the terms of quantum physics” (p. 38). In other words, it drives research efforts and builds off of the pursuit of unification. By this I mean it is integrally connected to the concept of unification and, as I argue, builds off of the successful presentation of a theory that provides unification. It is the romantic tale of overcoming division, and being crowned with the jewels of a new reign. This reign functions as the induction of a Theory of Everything.

When string theory discourse arrives at discussions of Theory of Everything, the romantic journey now takes on more explicit discussions of faith, of impending doom to enemies of the forthcoming theory, and of a blissful conclusion to a perplexed history of physics research. We reach the end, and do so in a biblical, allegorical form.

In arguing that a blissful existence can be achieved, string theorists look forward to the day when string theory is firmly established as the Theory of Everything. They write about it with hope and of the necessity to exercise faith that the day will come. Plato’s idea of a perfect society is a reflection of the potential to create a premium existence, whether it be in human civilizations or just amongst physicists. In *The Republic* (380 B.C.E.) Plato wrote of human passions that needed to be tempered by a love for philosophy, and which passion for philosophy would be taught by a reigning philosophy. In string theory, we have a theory which is presented as such a grand, conclusive existence. It is accessible for argument because string theorists draw upon the importance of a phrase that has special meaning for physicists: the Theory of Everything.

Faith

As the audience to string theory discourse we are given examples to follow in showing zeal for string theory as the Theory of Everything. The string theorists themselves demonstrate faith that string theory is, if not itself, the first step to the Theory of Everything. In *Parallel Universes*, Michio Kaku (2005, August) says that physicists simply refuse to live with such a proposal of disorder in physics, suggesting the necessity of finding a Theory of Everything, “Einstein spent the final three decades of his life searching for such a merger,” which he likened to "reading the mind of God” (p. 31). The collective determination that is shared by the group of string theory proponents to argue that string theory is the Theory of Everything illustrates the intensity by which they exercise faith in the theory. The dream of such a transcendent existence for physicists is thrilling. Just as Plato believed in the heaven he employed rhetoric to argue for, string theorists are thoroughly convinced in the reality of a Theory of Everything being on the horizon via string theory.

I need to emphasize the linguistic nature of this analysis of faith as a secular term, or at least a secular translation from the term in which it serves different purposes than “religious faith.” When the string theory proponents speak of faith and belief, they mean a secular faith, an optimistic assumption toward positivistic rationality that is not experimentally proven, but is hoped for and assumed. Therefore, although deeply mythic and religious in its expression, here the language is quite secular as it uses faith as more of a metaphor to describe what our relationship should be with string theory.

Brown and Davies (1988) state that the search for the Theory of Everything is an "act of faith," and that it is motivated by "deep faith [in] nature" (p. 6). Halpern refers to it as a scientific "theology" (p.172). Language of heavenly manifestation is also often used, such as Gary Taubes' (1986) referring to string theory, as the unifying theory, as something that is 'beautiful, wonderful, and [most accurately as a religion/faith theme] majestic" (p. 34). And Halpern refers to a Theory of Everything with the heavenly quality of being "virtuous" (p. 172). The religious metaphors get even richer. Taubes (1986) describes string theory as the Theory of Everything as a "mathematical miracle" (p. 54). He states that in physics we have an "intriguing miracle" (p. 54).

The current set of string theory proponents, such as Brian Greene and Lisa Randall, recognize and revere the string theory pioneers who went before them in earlier decades. The legacy set by early string theory proponents has set a legacy for current proponents to live up to. Recognizing pioneers is a demonstration of faith. Defeating string theory's challenge of doubt about being the Theory of Everything is the last task.

Even as it is framed as the final theory, string theorists still have an uphill battle to convince experimental physicists that they are studying in a legitimate paradigm. Their faith in the theory is met with skepticism from other physicists. The key argument against the theory is its lack of empirical and experimental evidence. String theorists have embraced the challenge of this argument against the theory, and use it to demonstrate how the theory is moving in the right direction. That vision is shared with readers in a way that encourages audiences to share in the faith because of the urgency to meet the needs of division, the rhetoric of which creates an itch for string theory audiences to, like string theorists, want the solution as soon as possible. Physicist Sidney Perkowitz (1999) writes that although the experimental evidence may seem far away, the hope for such evidence nonetheless guides physicists toward finding the called-for experimental evidence:

> The risk seems enormous when we consider that the most direct test of string theory would require a particle accelerator at least the size of our galaxy. For the ultimate benefit of physics, and to save a great deal of theorizing from going to waste, let us hope that a more attainable test will show whether reality truly does dance to the music of these particular strings. (p. 1780)

While lack of experimental evidence is used against string theory, its proponents are firmly grounded upon recognizing the problem of division and therefore promising to resolve the complex issue in physics. And with rhetorics of optimism toward finding evidence, readers of string theory are encouraged to maintain faith in eventually finding evidence, and for the time being to keep itching away at the reality of division in physics.

Yet in public string theory discourse, the focus is not on addressing the concerns of string theory critics, but in giving us, as audience, reason to believe in the theory as the Theory of Everything. String theory proponents continue to truck along toward romancing us and convincing us that even though the experimental data has not yet arrived, the mathematical reasoning is sound. And for that reason, it should be good enough for us. Eventually, we realize why intense language leads us to exercising faith in string theory.

So as string theorists prize the concept of a Theory of Everything, their challenge creates an opportunity for string theory's enemies to disdain the faith of the theory's proponents. Just as Plato needed rhetoric to lead people to subscribing to his conception of the good life and heaven, string theorists must carefully create a form of discourse that addresses the challenges between string theory and evidence to achieving Theory of Everything status. To do so, proponents employ a rhetoric of urgency. String theorists seek to intensify the seriousness of a Theory of Everything. The time to exercise faith is now.

Faith is exercised through adopting a mindset that shows faith in string theory as the Theory of Everything, and is presented in a format of rational thought. In his 1987 *Physics Today* article, John Schwarz demonstrates the process of thinking that should be employed, in order to operate in a way by which string theory is the theory of everything:

> During the past three years many theoretical physicists have dedicated themselves to working on superstring theory. With varying degrees of conviction we believe we have at hand for the first time many of the essential ingredients for an almost unique quantum theory that gives a unified description of all elementary particles and the forces between them. We also believe that this theory is free from the inconsistencies that have thwarted all previous attempts to construct a 'unified field theory' that describes gravity together with the strong, weak and electromagnetic forces. In short, we as some popular media like to put it, we may finally have 'the Theory of Everything.' (p. 33)

Words of faithful, religious hope are found in two of the descriptive choices Schwarz uses. He uses the word "believe" to demonstrate the confidence he and his colleagues have in string theory. He also stresses that we become "free" as we trust in string theory. Waldrop stresses, like Schwarz, that we become "free" because of string theory (p. 1251). Schwartz wrote of this optimism only three years after the Green-Schwarz discovery.

Along with exercising faith amidst criticism, string theorists also demonstrate the importance of patience. Edward Witten (1988) expresses his optimism in an interview about how important the Theory of Everything is, and how he thinks string theory is it. With his typical confidence and patient optimism, he contends that the theory will eventually be experimentally proven:

> I don’t like to speculate about Theories of Everything, but what I will say is that I really believe that string theory is leading us to a fundamental new level of physics, comparable in scope to any of the advances that have been made in physics in the past. At the same time I think one has to regard it as a long-term process.” (p. 96)

In this statement Witten explains how the idea of a Theory of Everything is not taken lightly. It is serious business that he and his colleagues address delicately. Patience is an important element of faith. Here Witten is demonstrating patience for string theory to be accepted as the Theory of Everything, comparable to how believers exercise faith in a promised hero who has not yet arrived. He speaks of the importance of patience in our journey to discover the Theory of Everything through researching string theory. This is because of Witten’s stated cautionary stance toward claiming a Theory of Everything will be accepted immediately by all physicists. By explaining the power of the Theory of Everything phrase he recognizes the special nature of string theory’s potential to actually become the Theory of Everything. Witten’s respect for the term functions to rebut any possible notion that string theorists are jumping the gun on the potential for string theory to become a true Theory of Everything. As audience, we are therefore understood to be acting patiently, somewhat skeptical yet still hopeful for the theory to become the Theory of Everything.

Further, Witten gives attention to the true originality of string theory. He discusses its potential to offer something new. It is through the expression of new scientific findings that the Theory of Everything becomes the final destiny of scientific progress. This sheds further light on the argument of string theory being part of nature that is intentionally revealing itself to humanity. That is, string theory becoming the Theory of Everything is not a forced pursuit, but a natural ramification of discovering the mysteries of the universe.

We also have examples from the most famous of physicists. As part of string theory being established as a Theory of Everything, we are told about how the ultimate legend in physics exercised faith in a Theory of Everything. Halpern spoke of Einstein's persevering devotion to finding a final theory. Einstein was taken to a play by his friend Charlie Chaplin in Los Angeles near the end of his life, and was brought to tears by a character who was left alone by the world. Einstein's faith in a final theory was reflected in his identification with the character, "The silent screen character with the rumpled clothes and the mustache—so alone and so misunderstood—never gave up. Neither would Einstein" (Halpern, p. 148).

As an audience, the task has now been placed upon our shoulders. We will be rewarded for our faithfulness. If we 'endure to the end, we will see the final theory come about and we will be in communion with the heavenly cosmos, "God's construction of universal laws must have been complete" (Halpern, p. 172). In the end, we are taught to transfer a part of our religious faith (or at least our cultural tendencies toward religious faith) to be placed in the potential of string to be a Theory of Everything, a theory to bring us to a promising place in understanding the universe because we know we must exercise faith.

Part of the challenge for string theorists is resurrecting discourse that is acceptable as final theory. The beginning of that discourse is Theory of Everything is faith. Finding a Theory of Everything was at one time an essential element in physics research. Discouraged, many physicists gave up on the dream of a Theory of Everything because there seemed to be no way of finding a union between the two major theories. Eventually, much of the world of physicists moved beyond the belief that such a grand theory was possible, due mostly to the inability to link general relativity and quantum mechanics, as well as the need to work electromagnetism into the equation. That is until the thundering night in Colorado in 1984. As F. David Peat (1988) writes, “What was needed was some dramatic, new idea, a move in a totally new direction. In 1984 that direction was signposted. Its name was superstrings” (p. 95). Although most physicists do not currently embrace string theory due to lack of experimental evidence, the discovery made that night nonetheless re-opened the possibility of finding the Theory of Everything for many physicists, whether they be string theorists or not. It re-awakens a sense of faith among many physicists. Faith is grounded in being told of what is coming, of good news, of redemption that is on its way. In biblical traditions, faith is connected to prophecy.

Prophecy

The idea of string theory as this long-awaited Theory of Everything began emerging in scientific articles within the first two years after the Green-Schwarz discovery in 1984. Early on, proponents of the theory saw the significance of recognizing the roles of key figures in the breakthrough. Theory of Everything became an instant, integral part of the discourse. Before the Green-Schwarz discovery, such an argument would not have been taken seriously.

And those long awaited days of being taken seriously came. Articles that function to popularize string began to emerge in science periodicals after the Green-Schwarz discovery in Colorado in 1984. Physicists supportive of string theory first published their initial findings inside the specialized literature of physics scholarship. From there, came the growing number of physicists interested in researching string theory. One year after the Green-Schwarz discovery, physicist Mitchell Waldrop (1985) published his article "String as a Theory of Everything" in *Science.* In 1986, *Discover* and *Scientific American* published articles describing how string theory had arrived on the map of physics. One of the key articles, which introduced the non-scientific community to the world of physics, was Gary Taubes' 1986 essay in *Discover.* Taubes tells the story of the Green-Schwarz discovery and of these pioneers' joining efforts with Edward Witten. In the same year, Michael Green published an article in *Scientific American* with the bold title, "Superstrings." Then in 1987, John Schwarz joined his colleague Michael Green as a popular advocate in the widely-read journal *Physics Today* with the same title used by his friend who he shares fame for the groundbreaking discovery: "Superstrings." Within three years of the Green-Schwarz discovery, string theory was introduced to the public as popular science journals shared the zeal of the claims of string theory as popular science literature arrived in the mailboxes of readers throughout the world.

In religious traditions prophecy is spread. It is recorded and preached. The popularity of string theory as the Theory of Everything continues to grow. Such is understood in Christian traditions of Jesus being the arrival of the constant prophesied savior who was spoken of by Old Testament prophets. For example, University of Michigan physicist Michael Duff (1998) compares string theory discourse to biblical prophetic orations, “scientific revolution to a group of ‘millennial Jeremiahs’” (p. 64). From the mid 1980s until now, journalists and scientists have been weighing in on the fascinating universe, which is given to us through string theory. A search for “string theory” on Amazon.com turns up dozens of books written on the topic, and which are still being explored as new volumes are written and new ideas of string theory are developed (Gubser, 2010; Jones, 2009; Zwieback, 2009).

As part of the prophecy theme, we must recognize that the search for a final theory is ancient. According to Nobel Prize laureate and supporter of string theory Steven Weinberg (1992), the search for a Theory of Everything has been sought since Socrates walked the streets of Athens. The first attempt at such a final theory was in the fifth century when Greek philosophers came up with the idea of “Atomism” (Davies & Brown, 1988, p. 2). Since then, many have spoken of the day that the Theory of Everything will be discovered.

Books of prophecy spell out series of events that will transpire during apocalyptic times. In physics, a Theory of Everything will meet criteria that are established to create a sense of impending events. String theory discourse is ripe with these forms of apocalyptic criteria. John Ellis says that “we will eventually discover all the elements which go together to make a Theory of Everything" (p. 166). And "we [will] eventually reach the Theory of Everything somewhere off in the distant future" (p. 166).

Along with tradition of prophecy and descriptions of how it will happen, string theorists speak of scientists who are guided by providence, and in which their destiny is string particles and extra dimensions. For them, nature is guiding us, teasing us along to discovering its hidden mysteries. In this metaphor, it is as if the laws of nature want us to discover the final Theory of Everything. Steven Weinberg (1992) writes about this mystical force that is teasing string theorists along, "Sometimes in discussions among physicists, when it turns out that mathematically beautiful ideas are actually relevant to the real world, we get the feeling that there is something behind the blackboard, some deeper truth foreshadowing a final theory that makes our ideas turn out so well" (p. 6). "Mathematically beautiful ideas" offer readers an aesthetic quality to exercising faith in string theory efforts at offering a theory of everything. In Weinberg's argument for the mystical, we see that nature is keeping a close eye, teasing physicists along, continually prodding them to realize the reality of strings and extra dimensions.

Another way string theory proponents prophesy of string theory as the Theory of Everything is by stating that through string theory nature is revealing itself to us. It is a form of divine revelation. Scientists end up finding that their conclusions take them to string theory in one way or another. When they extend the mathematical equations of physics in order to discover the deeper questions about how the universe works, they continually come to the conclusion of vibrating strands of energy, commonly known as strings. Brown and Davies (1988) head the section of the introduction of their book with the bolded wording, "Unity at the heart of nature" (p. 6). This implies that string theory naturally emerges as scientific reasoning continually developed. String theory did not emerge out of a research question that sought to unify the conflicting laws of physics, at least for early scientists. Rather, as scientists continued to try to use math to describe the world, they accidentally came across the equations that offer unification, and the subsequent Theory of Everything that is repeatedly associated with string theory mathematics.

For audiences, string theory comes to be understood as an existent part of nature that is taken and then applied to a particular problem that physicists may be working to address. String theory simply exists as part of nature and is faced with the challenge of having something to do with the questions with which humanity is currently trying to deal. In this instance, string theorists borrow from the notions of a sort of secular Zion, which is understood as a community dedicated to absolute union and peace. Here I turn to the drama which we witness, but which we are not part of as audiences. We get a picture of the events that happened between the scientists. And while we are on the outside looking in, we are given the theme of "lead by nature" as our guide to looking at these physicists' combative arguments about string theory.

Indeed, all physicists who have sought to find a Theory of Everything, and particularly those who have positive perspectives on string theory, are portrayed as having keen relationships with the laws of nature, as if they are being guided by a supernatural intervention, with which the universe is guiding them in their discoveries. Famous physicist Michio Kaku (2005, August) discusses this strategy in his *Discover* article titled "Testing String Theory," in which he traces efforts to find a final theory and concludes that on this journey, we are on the verge of finding what we are being lead to. For Kaku, it is a path laid before us,

> Throughout modern history, the discovery of each new unifying principle in physics has sparked stunning new practical insights. Isaac Newton's laws of mechanics paved the way for steam engines and the industrial revolution. Michael Faraday and James Clerk Maxwell's insight that electricity and magnetism are two aspects of the same force, electromagnetism ultimately unleashed the age of electronics. Einstein's realization that energy and matter are interchangeable helped usher in the nuclear age. We can only guess at the discoveries that might follow the confirmation of string theory. (p. 31)

We are left with the task of patiently waiting, of hoping for the redemptive day to arrive. The rhetorical power of the prophecy theme is in an argument of inevitability. It claims that we are on a path of destiny. When a rhetor can prove with multiple examples, as in the Kaku argument, it becomes hard to not believe nature is leading humanity on a path to destiny.

String theorists and their predecessors who sought to find the Theory of Everything are framed as oracle-types who are in connection with God, or at least with the true form of nature. In his efforts to unify, Einstein was a “minister counseling his flock, Einstein presented his assistants with an implied list of virtues and sins” to his young colleagues (p. 171). Halpern tells a similar heavenly manifestation that Einstein experienced, “Despite his disinclination to mix science with religion (in the conventional sense), these injunctions took on a biblical tone” (p. 171). Halpern then literally connects string theory prophecy to divine intervention,

> Einstein based the legitimacy of a 'Theory of Everything' on whether or not God would have made the universe that way. In that sense, his guidance was an attempt to read and interpret divine preferences. 'Let me see, if I were God, which one of these would I choose?' he would sometimes remark when considering various options. (p. 171)

Ultimately, we are told we are being lead to the final conclusion, to the Theory of Everything. String theory thus promises to merge the equations describing the action of the tiny world we cannot see--that of subatomic particles--with the equations describing gravity and the large-scale world we experience every day.

Theoretical Armageddon

No prophecy is exciting without the promise of intensified confrontations of good and evil. Apocalyptic language functions to raise the stakes of any given topic under discussion. After being told of the devastation of division in physics, and of string theory's capacity to unify the fragmented theories, the stakes are raised even more through intensifying language that consistently surrounds arguments about string theory successfully becoming the Theory of Everything. Words such as a great "culmination" being stated as going to happen as string theory becomes more verified in physics tells us that something big is coming (Salam,1990, p. 79). And according to Schwarz (1987), string theory is becoming the Theory of Everything at a "breathtaking pace" (p. 39).

Overcoming enemies is a common theme in Armageddon rhetoric and works in the presentation of a Theory of Everything. Peat (1988) employs military metaphors in describing the pursuit of the Theory of Everything, "From now on, an army of theoretical physicists would shift their focus from particle to string theories. A revolution in theoretical physics had occurred" (p. 119). Adrian Cho (2004, November 26) calls these scholars "The Children of the Revolution" (p. 1426). The kinds of phrases that build excitement prepare us for an exciting revelation, which is impending. Something is on the verge of manifesting itself to us. In *Scientific American*, Michael Duff (1998, February) boldly states at the opening of his article that "The Theory of Everything is emerging" (p. 64).

The Aramegeddon theme feeds off of the heightened contention of division. The grandiose nature of such a reality-altering event of providing a Theory of Everything has to do with the solution to the division of physics caused by quantum mechanics and general relativity. After Duff explains the depressed state we are in with two paradigms, which do not fit together, he sets up a rhetoric of a Theory of Everything coming to fruition as he describes that the division between established paradigms will soon crumble, because a significant change will happen, "Something big as to give" (p. 64). In this phrase, Duff hints to us that at least one of the two paradigms will soon bow to a new boss, a saving theory that will bring the battle to an end. John Schwarz (1987) refers to the realization of string theory as the final theory being capable of offering us "profound implications" (p. 36). A Theory of Everything is so important to physicists that John Schwarz (1987) wrote in his *Physics Today* article and believes that in physics there is not a "more significant theoretical proposal" (p. 35). The word "significant" establishes importance and the need to turn our heads toward this impending event. And Peat recognizes the transformation that is taking place on the part of physicists themselves because of the emerging Theory of Everything.

In the midst of battle comes the need to draw a line in the sand and pick a side for whom you will fight. For physicists, it is an internal transformation for those who are being converted to the new theory, as they struggle to let go of their past struggles in order to find conclusive explanations of the laws of nature,

> Superstrings point even deeper, for they are forcing scientists and mathematicians to look into the heart of physics and change the mathematical language they have been using over the last 350 years. Its revolutionary implications may therefore extend beyond a theory of elementary particles and into new and even more subtle orders of description and fresh mathematical languages. (p. 6)

Peat uses language that empowers the progress of string theory as the Theory of Everything, stating that string theory is “forcing scientists.” To be able to have such an effect on scientists means the force behind the impending theory must carry a lot of promise and a lot of sound reasoning. But the significance of why it is so forceful comes in a later descriptive work of string theory as the Theory of Everything. Peat calls string theory “revolutionary.” And that such a big change affects the mathematical languages that physicists are accustomed to using in how they describe the universe. This discourse adds to the appeal for consumers of popular string theory literature.

Intensification of an impending Theory of Everything is contagiously transferred from string theorists to audiences. As audience, we come to share the excitement of the emerging Theory of Everything because string theorists and string theory proponents do too. This transformation happens as they share their experiences of realizing the importance of and excitement for a Theory of Everything in their own lives.

Theorists exemplify their sense of urgency for readers by reciting their own experiences with unification and Theory of Everything. Michio Kaku recalls being a young man when he heard about the death of Einstein and of his secret notebook (the notebook Einstein was using to create formulas that would be the final theory of physics, and which were at his bedside at the time of his death). That curiosity and realization that something great was going to happen in the world of physics, Kaku was inspired to embark on a lifelong tale into physics, in which he went on a quest to “know what was in that book.” On that book was the work of Einstein’s attempts at discovering a final theory. The ‘final days’ of physics coming to its conclusive theory is told in other ways. Peat calls it the “final step” (p. 119). It has also been called a “bold step” (Halpern, p. 1).

In any tale in which the stakes are raised, heroes are often able to draw upon external, often supernatural sources for strength and support. The Book of Revelation speaks of two prophets who will, before the Second Coming, fight their enemies with fire. The theme trickles into literature as well. *The Lord of the Rings* character Aragorn draws upon ghost soldiers in order to defeat his enemies (Tolkien, 1955). This strategy is in the string theory narrative as the string theorists are framed as having a revelatory relationship with nature. Intensification creates the circumstances, in which such supernatural tools are manifest to the heroes of the tale.

One of the foremost challenges in the use of mythic language is to create personae, both within the rhetoric of the narration and the people in the story. As I discuss this I need to address some of the challenges in crafting such *ethos*. Among the challenges in the string theory movement is the capacity to defeat the efforts of physicists who work to expose the string theory movement as mere philosophy and not experimental science. The implied argument against string theory critics is that such critics are stopping nature's progress. Such is the case with the blog, *Not Even Wrong*, created by Columbia scholar, Peter Woit, who created the site as reaction to the claims made in Greene's book-turned-documentary *The Elegant Universe.* Woit's site criticizes the efforts of string theorists to discover experimental evidence. Similar efforts include Lee Smolin's (2007) *The Trouble with Physics: The Rise of String Theory, the Fall of Science, and What Comes Next.* Through all this, string theorists must work to establish *ethos* in order to earn their audience's trust. Thus, in string theory, character is gained in obtaining the enduring principle of unification in one's goals, according to Aristotle, "character is almost, so to speak, the controlling factor in persuasion" (p. 38).

I bring *ethos* into the discussion of critics of string theory because being lead by nature is one of the most prevalent methods used by string theorists. Further, as far as I know no critic takes a stance against the 'led by nature' argument in string theory. This is largely because of the Green-Schwarz discovery, which proves that string theory is anomaly free. We have, then, a mathematical theory which pops up for theorists in multiple decades, and always with the same conclusions. The result is an *ethos*, which is largely unchallenged as string theorists make the claim that nature is on the side of the string theorists. The warrant behind the led by nature argument is grounded in the quality of mathematical equations. Physicists accept the principle that the laws of nature are demonstrated vial language. Thus, as a mathematical equation has been found that soundly shows string theory to be anomaly-free, scientists do not refute that the nature is presented in mathematical equations that are anomaly-free. In the end, string theorists are able to establish *ethos* via having a mathematically anomaly-free theory. Yet in order for this argument to work, faith in these tools must be demonstrated in order for audiences to believe that string theory as the Theory of Everything is a possibility.

The heroes in the Armageddon tale endure as they await a day of absolution. James Gates (2007) discusses the troubles string theorists have faced in seeking experimental evidence in his letter to *Physics Today*. He proposes how string theorists are going to get their revenge against these whom do not heed the prophetic call of string theorists as the days of finding the TOE come closer, “Researchers excited about superstring/M-theory are foremost and thoroughly dedicated and well-trained physicists. Accordingly, they are rooting most enthusiastically for the success of their experimentally driven colleagues, if for no other reason than the opportunity for vindication” (p. 16).

Like Einstein’s commitment to finding the final theory and working to find the Theory of Everything even until his last breath, we are to “fight for our beliefs” according to Paul Halpern, “To fight for his beliefs, Einstein drew upon what he saw as his most powerful arsenal: his ability to construct a unified field theory so comprehensive that it would include quantum effects as a natural consequence” (Halpern, p. 148). University of Chicago physicist Jeff Harvey explains the reason for string theorists maintaining faith:

> It is astounding and probably unprecedented that there would be that level of activity for that long in an area which so far has absolutely no tie to experiment . . . The reason we keep on with it is that it seems to lead to new physical insights and beautiful things, wonderful structures. While that may not be proof, it’s sufficiently convincing that there’s either something to it, or it’s got all the best minds in particle theory completely hornswoggled. (Qtd. in Taubes, 1999, p. 513)

After the struggles and fighting for string theory as the Theory of Everything, string theorists believe they are aiding science by ushering in a new age of peace and posterity in physics. In the hero tale, the battle of Armageddon leads to peaceful reign via a presiding figure such as a king or savior. That savior, which is preparing to arrive as the Theory of Everything, is string theory.

The path has now been set. The stakes are raised through intensification. String theorists have the laws of nature speaking to them. Before the final battle, heroes often realize their greatest task on the road to victory is faith in themselves and faith in their weapons. Being guided by nature in an intensified situation, string theory audiences are prepared to exhibit faith in string theory as the Theory of Everything.

Millennial Peace

Offering closure in theoretical wards brings a peaceful rest among physicists, as well as among readers who are told to exercise faith, believe in prophecy, and endure during the theoretical Armageddon wars. The happiness continues as "the end" image shows the hero riding off into the sunset. That sunset is the Theory of Everything. All has been resolved up to this point. The constant struggle to persuade about a transcendent reality, or a transcendent final theory, has come via engaging in the available means of persuasion.

The heavenly bliss that Plato wanted his audience to achieve could not exist without the employment of rhetoric. Plato could not avoid bringing his audience to hearing him play the role of persuader. The same happens with string theory as string theorists must put language in this situation, into key terms of unification and Theory of

Everything, at the forefront of knowledge. Being engaged within the world of rhetoric is our way of living in the world. Mass communication is ever-present and is part of our reality. We are then prone to believe that transcendence is possible as the string theorists lead us to the Theory of Everything. Thus, the romantic journey of achieving the millennial happiness of a final theory is not only shared by the knights who are clothed in the equations and language of string theory, but it is shared with audiences who are brought to the destination of Theory of Everything via prophecy and apocalyptic battle.

When string theorists write about reaching the day of having a Theory of Everything, they are speak of time in physics where there will be no quarrel between branches of physics and where the physicists will show absolute reverence for the final theory. Plato spoke of a similar society. In his *The Republic,* Socrates is forced to portray a perfect society, in which all people will be ruled over by a philosopher. Plato writes that "A philosophic ruler is not an impossibility" (p. 205). String theorists, in prophesying of the time of a Theory of Everything, share Plato's optimism.

In Plato's perfect society in which a ruler presides, people would learn to control the conflicting passions that are within them. The philosopher-king would teach them to do so. The desire to learn philosophy would reign over the human tendencies for selfish gratification. There would be order in society and in human life. Millennial string theory discourse tempers the passions of quantum mechanics, general relativity, and all other frustrations in physics. A Theory of Everything provides order. And as it provides order, it provides peace.

Such discourse pervades the conclusions of string theory in which Theory of Everything is promised, is prophesied about. Physicist Abdus Salam recognizes that there is much that is being overcome as physics is brought to its final, encompassing theory, "Could strings really be the Theory of Everything (TOE) combining all the known sources particles . . . If so, they would represent . . . one's endeavors to unify the fundamental forces of nature?" (p.79). The idea of a Theory of Everything is "hailed," as F. David Peat emphasized twice (p. 89 & p. 328). And in *Parallel Universes,* the narrator says finding the Theory of Everything is the attempt to know the "mind of God," similar to Kaku's (2005, August) wording as he describes nature's destiny being manifest in string theory.

Forms of discourse also tell us of the heroism of string theory at that great day. BMS (1987) states that string theory will "save the day" (p. 17). It is complete, strong, and promising. It is called the "perfect theory" (Peat, p. 119). The narrator of *Parallel Universes* agrees, "String theory sounds like a perfect Theory of Everything."
Two years after the Green-Schwarz discovery, science writer and proponent of string theory Gary Taubes (1986, November) elegantly described in his *Discover* article the beauty of finding a Theory of Everything, and the role that string theory plays in that vision. Taubes stresses one of the underlying arguments for a Theory of Everything: the various theories of nature have come to fit together, somehow miraculously,

> The theory has turned physicists into mathematicians, and mathematicians into physicists, and the universe into an entity in which all matter and energy, all forces, all people, planets, stars, cats and dogs, quasars, atoms, automobiles, and everything else, from the instant of the Big Bang to the end of time, are the result of the actions and the interactions of these infinitesimal strings. The Theory of

Everything, scientists call it—T.O.E. It just might be. Its certainly the best bet yet. (p. 34)

As string theory proponents move ever closer to concluding their discussions they become increasingly theological in their word choices. To come to the end of the journey is to find, and then partake of the Holy Grail. It is the Holy Grail that leads to having peace with god. As the Theory of Everything, string theory is framed as leading us to that victory and enjoying the fruits of our faith. Another prominent theme of sacred metaphor is calling the Theory of Everything the "Holy Grail." Note that in chapter 4 I highlight the use of the Holy Grail in describing the process of unification.

It is important to realize that the Holy Grail and the final destination of being with the divine are integrally connected and not discussed separately in string theory discourse, even though I treat them as a careful step-by-step process in my analysis. Therefore, in the process of using faith metaphors, string theory writers use the Holy Grail metaphor to illuminate the significance of how we ultimately arrive at this destiny of a Theory of Everything. Alan Boyle (1998, October 8), science editor of msnbc.com, titles his story about the movement, "The Quest for a Theory of Everything: 'Holy Grail' would Explain Relativity, Quantum Mechanics." Waldrop also refers to the Theory of Everything as the "Holy Grail" (p. 1251). And as the Theory of Everything, string theory proponents situate this Holy Grail in relation to the history of physics unifications that lead us to the Theory of Everything. Early on in his 1985 article in *Science*, science journalist Mitchell Waldrop illustrates how gravity is what string theory offers in its ability to address the concerns of the two contradicting theories, "What is most important of all, the superstring model at last seems to give the physicists their Holy Grail, a finite quantum theory of gravity" (p. 1251).

A Theory of Everything has brought us to God. It defeats all foes and has no more theoretical challenges ahead. In a more explicit explanation of the Einstein-as-faithful story, University of Maryland Physicist James Gates asks, "Why did Einstein want to unify? To know the mind of God, which means to understand the entire picture" (McMaster, 2003). The implications of ideas such as the potential for the existence of God, transcendence, and the role of humanity in the universe are what empower, enable, and give credence to the minds of audiences as to why it is significant that string theory offers us the Theory of Everything.

In his letter to *Physics Today* James Gates Jr. closes by stating that as string theory brings us to a close in the search for a Theory of Everything, it "would be a point of great pride to have clearly perceived 'the mind of God' (p. 16). And these string theorists efforts have put them on "grounds for sainthood in the Einstein cannon" (Halpern, p. 172). "Sainthood" demonstrates the believed-to-be victory over doubt about string theory and the significance of exercising faith in string theory as the Theory of Everything.

In the end, we are united with God, we come to know, because of Einstein's endurance up to his final breath to find the Theory of Everything, and we were able to complete the equation, to complete the work of nature revealing itself. We do this by heading the charge placed on us in the midst of the theoretical apocalypse: exercise faith in string theory as the Theory of Everything.

Conclusion

The arguments put forth for string theory as the Theory of Everything are exciting and convincing as we follow the tales of string theorists work for the Theory of Everything to come about. So far what we have read is the use of religious and mythic themes. Without a rhetorical analysis, the secular nature of the string theory movement will remain understood as solely scientific. Yet the religious nature of the rhetoric, upon closer examination, gives us something unique in the string theory narrative: a secular salvation.

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Chapter 6

Secular Salvation

In this chapter I explain how secular salvation develops and functions in popular string theory rhetoric. Secular salvation is dependent on the spiritual implications of the string theory movement. Its discourse, as shown in the analysis chapters, is richly theological. Here I describe how the subtlety of theological form is present in the discourse yet transparent. As a consequence, the scientific understanding of the universe offers us a form of salvation because it answers many of our questions about the cosmos. It is scientific in form yet theological in implication.

The process of secular salvation is illuminated when understood through comparison of rhetorical styles of scientific language by Burkean pentad (Burke, 1962). String theory proponents adopt discursive forms of purpose as opposed to the objective language of agency and scene, which are traditional modes of scientific explanation. String theory discourse is richly embedded, through discourse of purpose, with abstract attempts at synthesizing information for the sake of purpose.

String theory discourse empowers the language of unification and theory of everything. The narrative of heroics prepares these terms to succeed in careful argumentation through emphasis on correcting divisions in paradigms of physics. The rhetorical setup of chapters 1 through 3 describes, through narrative, the emphasis on division. Division empowers the discourse that is used in chapters 4 and 5 to solve the problem, or to bring transcendence and the necessity of faith.

Sometimes, although rarely, physicists draw literal connections between their findings and divinity. While discussions of the divine are not prevalent in string theory discourse, proponents still flirt with the theory's connection to God. Steven Weinberg argues that we might be drawing nearer to divinity as we continually learn about the exotic mysteries of the universe, particularly as we use a sacred metaphor to do so. This question is examined by the physicists themselves. Weinberg (1992) ponders this idea,

> Will we find an interested God in the final laws of nature? There seems something almost absurd in asking this question, not only because we do not yet know the final laws, but much more because it is difficult even to imagine being in the possession of ultimate principles that do not need any explanation in terms of deeper principles. But premature as the question may be, it is hardly possible not to wonder whether we will find any answer to our deepest questions, any sign of the workings of an interested God, in a final theory. I think that we will not. (p. 245)

The use of religious language allows string theory to be sacred, yet still secular in its claims. The salvation narrative is transformed and secularized as scientists draw upon language to persuade the public.

Physicist Lawrence Krauss (2005, November 8) discusses the relationship between string theory and religious dialogue in *The New York Times*. Interestingly, Krauss suggests that humanity's attraction to religious form in inevitable, "Does the longstanding human love affair with extra dimensions reflect something fundamental about the way we think, rather than about the world in which we live?" This is because, as Krauss states, "Religious belief that the universe is the handiwork of an all-powerful being is not subject to refutation." With the foundation of strings being the most miniscule of elements and the inability to access the extra dimensions, string theory share's religion's irrefutability.

Yet in this summative chapter we are less focused on the explicit connections between string theory and heaven than we are the subtle path that allows such connections to be made, by audiences, in order to see the theory as appealing. Nonetheless, addressing the inevitable presence, yet rarely explicit connections, serves to prove the point that string theory is indeed connected to the divine; if not by explicit comparison (as Weinberg and Krauss discuss) then certainly by the translation of available means of persuasion for a transcendent-reality believing culture. Yes, string theory proponents adopt theological form because it is an available means of persuasion because of its appeal to public audiences.

Summary

To grasp the structure and significance of string theory I have examined the situational exigency that organizes string theory discourse. The contradictory conventional paradigms of physics fix the problem string theorists set out to solve. This exigency is expressed in a discourse of division. The aesthetic appeal of unification becomes vivid. Studying strategies of separation, distress, and shame in division allows us to grasp the set up of the division between established theories of physics.

Because of division, the discussion of unification creates an audience longing for unification. String theory is the rhetorical process these rhetoricians employ as they convince their audiences of the necessity of unification. The process includes convincing audiences of the significance of incompleteness, the beauty of unification, and the peaceful restitution of bringing all into one. This is the re-presentation of a long held dream.

Accepting string theory as the Theory of Everything offers secular salvation to string theory audiences. Rhetoricians justify the importance of unification, and stress unification, which then allows the appeal for the Theory of Everything to be the conclusive argument. The implication is a secularized salvation story. We arrive at a new understanding of the universe that is based on mathematical reasoning that implies the near impossibility of understanding the mysteries of the universe.

Sacred as rhetorical resource

As symbol using animals, we find solace in turning to the rhetoric of the sacred. The evocation of the sacred gives the rhetor an immediate connection to audiences who gravitate to the sacred because of its appeal to audience values (Burke, 1966, p. 3). Burke (1970) explains that sacred language brings transcendence when humanity has questions, "If the symbol-using animal approaches nature in terms of symbol-systems (as he inevitably does), then he will inevitably 'transcend' nature" (p. 22). If the secularizing of the salvation myth could be captured in one phrase, then we might see it in the first words of Musser's (2008) *Idiot's Guide to String Theory,* "Through it, human beings will finally know the principles that ultimately govern the universe and make it a place fit for us to live in. Many of the aspects of the world that seem so strange to us now will fall into place" (p.1). As the string theory movement continues to unfold and grow in momentum, our understanding of the universe alters our reality because it gives us a secular salvation, which is available through the power of language.

The appeal to the sacred is as ancient as philosophy. For Plato, salvation in heaven is possible via philosophy. Yet in seeking a transcendent realm that escapes the five senses, Plato was forced to engage *logos*, *pathos*, and *ethos* in his explanation of heaven. Yet it was inevitable that he would employ rhetoric. To seek to get an audience to subscribe to a transcendent reality is to make language authoritative, such as Plato's concepts of dialectic as a method for discovering the gospel of philosophy. String theorists do the same. They present to us a transcendent reality and employ the special language of unification and theory of everything, which we subscribe to as authoritative.

Having desire for transcendence, we heed that authority. Transcendence has always been present in religious discourse (Burke, 1970). Theologically, we are told we have committed sin; we need a savior. In order to recruit converts, to get people believing in the doctrines of a religion, audiences must be shown that they are incomplete in their current circumstances. Or in other words, they must come to understand that they can reach a higher level of completion, a higher degree of consciousness, of happiness. That peace is accomplished through first realization of the Fall, or the problem the would that needs healing, the division.

The sacred implies heroism; the tale of redemption. String theory is spreading in large numbers of books and as more theoretical physicists continue to engage the possibility of the theory. It is only a matter of time until these efforts to promote unification become the revolution that brings about a new way of understanding the universe. Just as Plato put forth his epistemology of the forms through allegory, string theorists publicize their ideas through tales of heroic physicists told in literary form.

Genre

When sacred language is used to describe transcendent realities, which cannot be demonstrated, a story still must be told in order to explain how conclusions are drawn. Stories have protagonists and antagonists. A second form of discourse therefore takes on a subjective rather than objective, report-the-facts form.

Taking on a teleological assumption about nature, string theorists shape descriptions of their theory to take form that allows string theory to be presented in a linear fashion. Nature is then understood as guiding string theory's inception to humanity. Language choices then become important in the presentation of nature. Burke (1962) discusses the various options that specialists have when describing phenomena.

Sometimes language focuses on scene. When speaking with a focus on scene in relation to topics of transcendent truths we no longer speak directly of the existence of a larger, omnipotent deity; so we take out any references to personal vocabularies in our descriptions. In the end, when we discuss materiality of a scene, the language of objectivity takes form. We find a similar mode in the language of agency. Agency, an emphasis on empirical surroundings in our presentation of ideas, is mediation to get to the transcendent. The scientific method takes form of agency. It is not a complete reach to the real transcendent, to the personal so to say, "Empiricism can conform to the genius of Agency, in that the senses play a mediatory role, as we like to come to the mediatory in reducing everything to relations" (p. 287). Again, it is moving away from focus on the personal and into the adopting of language that implies empirical observation.

Yet in popular string theory literature, advocates favor a personal form of discourse. This is how string theory takes on a teleological form. It is spoken of more broadly and with purpose, "Purpose lurking behind concepts of 'Totality' or 'allness' which are but other expressions for the Unity which we have already related to purpose" (Burke, p. 297). That purpose takes on the form of the sacred, of destiny.

Purpose is implicit in tales of heroism. Plato employs them in his dialogues when Socrates takes on the sophists in the battle over rhetoric. The string theory story, taking on a form of perspective in which exigencies are overcome and victory is glorious, offers audiences an encompassing, holistic understanding of physics. When string theorists speak of physics in a broad sense that is without equations and with the integration of metaphors such as unification, the sacred and the vision of what can be reached begin to function together in a purpose driven form of rhetoric that suggests there is a destiny for readers. The pursuit of a grand purpose comes by the exposure of exigencies that need to be resolved.

Exigencies

An important part of the romantic genre is the transcendence over obstacles. In the popularization of string theory, both quantum mechanics and general relativity are simplified in comparison to the advanced scientific explanation of how they work, as is string theory itself. The messianic, unifying nature of string theory is presented as emerging from the darkness to redeem and satisfy the need for unification. As a result, the lack of unification between general relativity and quantum mechanics is the exigency that drives the need for string theory to be given to us by the ever-desiring to show itself to humanity, laws of nature.

Such language is best understood by another framework Burke offers us in *A Grammar of Motives.* The presence of exigencies is driven between the tropes of metonymy and synecdoche. Division, the trope of analysis, breaks apart. Synecdoche, the trope of synthesis, brings things together. The sacred works with synecdoche because unification and Theory of Everything are terms with are inclusive of scientific traditions. In other words, such terms are meant to "Represent," which Burke tells us "could be 'identified with'" (p. 508).

String theory discourse emphasizes metonymy. At the forefront of the redemption story, division, the theme of chapter 3, demonstrates the differences in science, or its theoretical fragmentation. The fragmentation then provides way for the synecdoche of unification and Theory of Everything to allow the healing synthesis to take sacred form because synecdoche takes on, by implication of its encompassing, broadening form, the discourse of purpose. While division takes on the form of agency in using divisive language, unification and Theory of Everything speak more encompassing and with the purposive language of collectivity.

Aesthetic form

Even with being purposive and collective, persuasion must still employ *pathos* in its presentation. As discourse becomes increasingly general, the subjective potential of purposive language opens up the opportunity for beauty, for grandiose appeals to themes of aesthetics. Such is accomplished in the sheer attraction, or beauty, of the theory and the way it is described. Gary Taubes connects this alteration in our perception of reality to experiencing aesthetic beauty in public scientific discourse. Nature is leading us to its origins, its grand understanding, which goes back, as Taubes stresses, to the Big Bang. String theory, as the theory of everything, leads us to a holistic understanding of the origin of life. String theory discourse is therefore more than a final theory of physics, but at the public level it draws upon something more primitive, more sacred,

> The T.O.E. is an obsession with physicists. The search for such a theory began more or less with Einstein, who, trying as he would, failed to develop one. The ideas is to write one theory, one set of equations, that will show the four known fundamental forces to be disparate manifestoes of one even more fundamental force. Physicists have pursued the T.O.E. for two main reasons. First, unification appeals to their sense of aesthetics. Why would nature bother with only three or four fundamental forces, and not five, or ten, or 207? A single supreme force somehow seems more sensible. Second, if in the Big Bang the universe burst from one unimaginably hot point, then at first all four forces would have had equal strength, and would have been, in fact a single force. All particles would have been indistinguishable from one another in this inferno-to-beat-all-infernos, and may as well have been from one and the same. (pp. 37-38)

There is something truly aesthetic in these forms of discourse, which create wonder and make the audience begin to resituate their perspective on reality. As a public presentation of a complex idea, string theory enters in and uses a discourse of elegance, which appeals to audiences prone to the ideas of sacredness.

Metaphoric invention

As aesthetic presentation and description are present in the hero tale of victory over villainous exigencies, the terms and their theological scope require attention in this overview and conclusion. In string theory, the appeal to notions of unification and the theory of everything present unique epistemological claims. These powerful and encompassing ideas are tropes, which have appeared in other scientific discourses.

Scientists have used these different forms to translate the potential of a transcendent existence, of which the linguistic notions serve as evidence. The result of this type of translation is the constant usage of metaphoric terminology in a given scientific movement, where language itself is the essence of the claim. Certainly, language of purpose will push and engage the most encompassing types of metaphors.

The available metaphoric language of string theory, in its purposive style, replaces the need to refer to material observation as the essence of persuasive reasoning. Metaphoric language continually pulls the material to the transcendent. *Language itself works as the evidence*. In other words, the inability to provide proof in the laboratory leads to scientists' bearing the burden of having to work within the harsh world of rhetoric where persuasion must be employed with careful, methodical choices of language.

When we enter the world of metaphoric choices for the sake of artistic form, we are engaging in the work of persuasion. As John Muckelbauer (2008) writes in tackling the problem of invention, "Perhaps it can only be *demonstrated* performatively. To speak about it, to try to explain it . . . is necessarily to speak in an inexact and imprecise language" (p. xi). Certainly, any attempt to walk technical ideas to a more simple level, and to do so with the attempt to provide an encompassing theory means efforts at invention can either succeed beautifully, or fail miserably. Yet when simplified into terms such as unification and theory of everything and situated within an important piece of history, the quasi-theological nature of it works on an enthymematic level are awakened in the mind of audience.

Rhetors who are involved in the same goal and share the same language when describing the proposed theory demonstrate through their own behaviors how to reverence the key terms. This process allows metaphors to effect the thinking process of audiences. As Lakoff and Johnson say, "New metaphors are capable of creating new understandings and, therefore, new realities" (p. 235).

Invention is the work of re-inventing, or translating, previous rhetorics, which were employed in other paradigms of thought. Theological ideas are dissolved and then resituated in the rhetoric of an upcoming scientific movement As a result, scientific employment of religious metaphors and language has much to do with usage of fragmented ideas from older discourses, which are now available to be used in a scientific recycling of the sacred, "one might accidentally imitate only surface characteristics or ignoble qualities of one's chosen model" (Muckelbauer, p. 59). Nonetheless, those fragments will continue to be present in other forms of discourse that will borrow from the original thought, which is directly connected to the original belief. The ideological determinations will still be present in that discourse as well, making not only the possibility for those fragments to be adopted by another but the ideological history of those fragments will continue to exist.

The result is that the epistemological assumptions that were in the linguistic DNA of the originator will still be transplanted into the notions of the borrower. The uses of unification and theory of everything, which help to drive popular string theory are, to a large degree, the fragments of dissolved theological notions. The result: those ideologies are still present but re-organized, re-situated in the effort to bring unification in physics and provide humanity with a conclusive understanding of the universe, a theory of everything.

Enthymeme

Metaphors that are translated from other discourses must be adapted to appeal to the tastes and preferences of the audience. In string theory, the arguments and narratives invade our enthymemes for the sacred in new forms; the presentation to vernacular audiences is a gospel of secular salvation.

Yet we must discuss how popular science and its employment of religious terminology starts with a blueprint, or stated more explicitly in rhetorical analysis: an act of rhetorical invention. There are various elements weighing in on the emergence of the popularization of string theory as its proponents seek the means of invention in the effort to offer a new understanding of the universe. This is done by translating forms of argument used by other, older discourses, and doing so via 1) the development of heroes who are on romantic journeys, and 2) putting the burden of faith in the theory on the audience.

One form of enthymematic persuasion is in asking readers poignant questions, which force them to connect the dots between their beliefs and the ideas in string theory.

As an example, in the concluding chapter of his work on the history and significance of string theory, Halpern (2004) not only asks questions that capture the essence of what this movement does for the world of physics, but for humanity's understanding of the universe in general. Ultimately, our very reality will be shifted into a novel form of understanding the universe,

> What if it's all true? What if tests show conclusively that Kaluza, Klein, and their successors were right about the hidden recesses of space? Suppose higher dimensions prove essential for describing all aspects of physics with a simple set of principles. How would this momentous discovery change our culture? In particular, how would science convey these ideas to a public used to associating higher dimensions with the occult, if it considers them at all? (p. 4).

Proponents of string theory work to persuade the broader, more expansive audience who are, due to lack of scientific training, readily situated to be persuaded by those who have scientific credentials. To do so, string theorists must tap into enthymemes in their efforts to persuade general audiences who do not have specialized scientific knowledge. The significance of the term unification emerges out of the contradiction between the theories of general relativity and quantum mechanics, leaving us facing a contradiction of an unordered, chaotic, and messy universe. String theory offers us a solution to the chaos.

String theorists address this concern. They give their audiences not something which is a mess, but something which is, in the words of Brian Greene (McMaster, 2003) "elegant." The key strategy for giving order to the universe is in the offering of transcendence via the romanticized tale of bold string theorists.

This is found in the capacity for translation to take place, as technical concepts are made available for public understanding. This is a translation that takes place in the minds of the rhetor and in the minds of the audience. The rhetor does the work of drawing upon historical beliefs of the audience. The audience then attaches meaning to the new idea because it is connected to previously held assumptions and values. This is not a simple process which is strategically accomplished, but is the result of the complicated process of translation. Much of this argument has to do with the concept of unification as an enthymeme in cultural notions of sacredness. I argue that unification is a historically theological principle, which comes in various forms—"become one with God," "love thy neighbor"—and to therefore succeed in this sense, "Speeches using paradigms are less persuasive, but those with enthymemes excite more favorable audience reaction" (Aristotle, p. 41). Invention in popular string theory discourse has as much to do with inventing history and heroes in the movement just as it does describing the theory itself.

Getting audiences to see the reality of the theory of everything is based upon the notion that the universe is much more complex than meets the eye—literally. Important to this study, which reverence for string theory is demonstrated in the mythic telling of the emergence of a theory that continues to struggle, yet has significant promise for humanity's understanding of the universe. This is a key to successful persuasion.

Although the theory's supporters translate its ideas from more ancient, yet still subscribed to notions of reality, it does so subtly. The implication of subtle, small pleadings to accepting string theory as the theory of everything comes as the audience can then connect, in their own minds, the notions of string theory with their previously held belief systems about hidden truths in the universe that escape our eyes.

The transference from being persuaded to believe that there is a reality, which transcends the natural world, is a logical one that is based on scientific reasoning. It is an argumentative notion that must resort to explanation and is therefore incapable of not using language, and therefore cannot avoid borrowing from other discourses. In other words, it cannot avoid translation in attempts for invention. Ideas do not truly have a complete, original invention. As string theorists construct a rhetoric of unification, their attempts at invention lead to, as do so many other things, the translation of the sacred into new discourses that are driven by new motives. The enthymematic use of the sacred in string theory discourse is an Aristotelian process because it employs language, narrative, and argumentation. It is Platonic at heart because it is an effort of putting forth a transcendent reality. It is sacred as it employs the romantic journey of heroics.

Reflection on method

In this study of string theory discourse I have created a framework for analysis; the nature of linguistic resources and choices being part of a dichotomy that permeates rhetorical invention. Plato and Aristotle argued about the nature of humanity and our relationship to the cosmos long ago. These two philosophers polarize themselves on opposite sides of the spectrum in regards to understanding the human condition and what role language plays in our attempts to transcend exigencies and gain knowledge. The result is that appeals to sacred themes emerge as purpose-driven discourse leads to use of narrative and metaphor.

While Aristotelian rhetorical theory became the curriculum for teachers of rhetoric, the Platonic denial of rhetorical invention as an ever-present process prevailed. The tension on the function of rhetoric continued during the European Enlightenment with the rise of modern science. For Descartes (1637), rhetoric was the enemy of science. All that was necessary for explanation and persuasion was to restate the method of discovery for the audience. Yet, the inadequacy of such a suggestion—perhaps the very impossibility of such a transparent use of language—became obvious. Even Plato succumbs to the tendency to argue through narrative. In the end, as we look at the role of rhetoric in more sophisticated modes of subtle persuasion, we realized that the use of Aristotelian artistic proofs is a constant.

For all of Plato's complaints, Truth is given expression through the invention choices described by Aristotle. Truth is not independent of culture. Truth is given expression through the storehouse of commonplaces recognized by the audiences, to which discourses are addressed. This process of invention shapes their popular meaning and reception. As rhetoricians draw upon previous discourse and find new artistic forms to express them, narrative and metaphor do the work of *ethos*, *pathos*, and *logos*.
I believe this implies that scientific rhetoric will, upon the translation of specialized knowledge into language, which is accessible to the public, take on sacred form. It is inevitable. It is a tendency that transcends time. Language implies the sacred, as Burke suggests. Yet the very introduction, the very resources available, leave proponents of scientific theory with nothing more to use in their rhetorical expression than employing sacred appealing to popular beliefs.

Cultural consequences

If a contribution to theory means that public discourse will inevitably take on sacred form, what are we to assume about string theory becoming the “gospel of secular salvation?” Argument for science simply remaining science without religion is one consequence. Even though science takes on sacred forms, it is still science. It could be said, ‘We are simply taking on the forms of discourse, which naturally exist. This doesn’t change the science.’ The answer to such a claim would require reference to the very origins of science itself. Scientific knowledge is, in the creation of its very reality, grounded in appeals and desires for the sacred because language is the culprit from the beginning, as I discuss earlier in my treatment on naturalism.

Yet for the religiously grounded audience of these implications, what happens when science is the form of salvation? Is science merely filling the void, the need to feel connection with the cosmos and to have purpose? Therefore, do we reverence and worship a God that takes on form only in the instance of language available and appealable to audiences? Would such be a God without concern for humanity?

The historical God of revelation is the story of the religious. Perhaps the story of the rational mind is the story of a God of laws. Regardless of the form, followers of God will seek out and listen to the carrier of the priestly voice. Prophets and scientists take on forms of offering explanation and promise to audiences. Does a scientist offer the same accessible comfort for audiences that religious leaders offer? Scientists certainly have not replaced clergy, yet their form when addressing the public is similar. And importantly, scientists accumulate followers who engage in the sacred form of secular salvation because it, like religion, promises to provide answers to humanity’s fixation on pondering the mysteries of the cosmos. In both cases, the rhetoric offers explanations. And such explanations are accepted as reality. For audiences of public discourse, salvation comes as, whether in the potential for redemption or just its presentation and reception, the product of rhetorical invention at work.

Limitations and future research

String theory is young. While it is growing and is strong enough to make enemies in the world of physics, its public dissemination is still rather young in comparison to the venerable physics of Einstein. If string theory gets accepted as the reigning paradigm of physics, we will be able to explore more fully the chaining out of the discourse into other discursive domains.

In this project I have not closely looked at historical comparisons. String theory has much to do before it can be comparable to the Copernican, Newtonian, Darwinian, and Einstein-ian revolutions. If it is not found to be sound in conclusive evidence, then at least it might be comparable to earlier revolutions in campaign efforts. I have suggested that the positing of a multi-dimensional reality changes the way the discourse will chain out. However, I have not done any close historical examinations of this.

With an interest in vernacular rhetorical appeals, I limited my texts to professional productions – popular science magazines, popular books, and documentaries. As a result, I did not look at sites where religion and science are discussed. Exploring this domain could lead to a richer understanding of the public presentation and reception of string theory. Yet in these settings, perhaps the simplicity of vernacular dissemination loses its accessibility.

Finally, although I drew on the genre of science fiction to explain rhetorical invention in science, I did not examine works of science fiction that have created string-theory-like narratives. Does string theory return the favor for science fiction? That is, do they, in fact, resemble the popular discourse of string theory? Examining the portrayal of string theory in science fiction might unearth the role of string theory as a public appeal for storytelling.

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