Religious Appeals in the Popular Presentation of Cosmology

by

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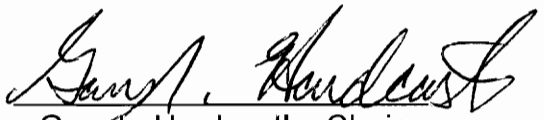

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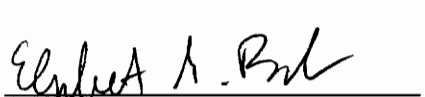

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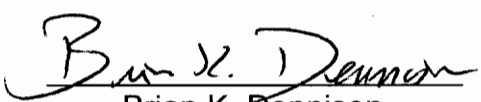

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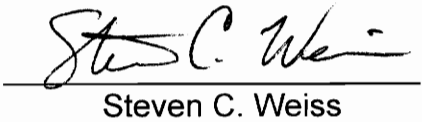

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(ABSTRACT)

This thesis explores the use of religious language, metaphors, and images in the popular presentation of cosmology. Specifically looking at books written by cosmologists and intended for a lay audience, I argue that these religious appeals present a particular model, or picture, of cosmology to the public. Through the religious language, metaphors, and images, the texts create scientific-religious imagery which gives cosmology and cosmologists religious functions (e.g., the metaphor of cosmologists as priests). Taking these images together, the texts present a model in which cosmology performs like a religion -- a model of Cosmology-as-Religion. Thus, the religious appeals appropriate religious authority through cosmology's assumption of religious functions. However, the texts also contain arguments justifying cosmology and the need for its continued financial support. The texts link these justificatory arguments to the scientific-religious imagery, and this associates the texts' appropriation of religious authority with the justificatory arguments. As a result, the appropriated functions give cosmology additional social benefits, providing a socio-religious context to the arguments. This, in turn, increases cosmology's importance to society. In this way, the religious appeals help legitimate the justification of cosmology.

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CHAPTER 1: Introduction

Introduction

The scene: an empty room with a black floor and dark background. In the middle of the room sits a man in a wheelchair. The light focuses on him as we see his face and upper body. Over the background music, we hear a mechanical voice.

"If we do discover a complete theory of the universe, it should in time be understandable in broad principle by everyone, not just a few scientists."

The picture changes to the right side of the wheelchair. We see the man's hand operating a control pad that rests in his palm (the control pad operates the mechanical voice).

"Then we shall all, philosophers, scientists, and just ordinary people, be able to take part..."

Now we see the bottom of the wheelchair -- its rubber tire rests motionless on the glossy black floor.

"...in the discussion of the question of why it is that we and the universe exist. If we find the answer to that,..."

Once again, the picture shifts. The wheelchair faces away from us, superimposed on a black backdrop. We only see the back of the chair which obscures our view of the man. A red warning light rests on top of the maroon and red wheelchair. Dangling from the back is a license plate that reads 'STEPHEN.'

"...it would be the ultimate triumph of human reason -- ..."

The darkness gives way to the stars of the night sky. As we watch the wheelchair travel out into the universe, the mechanical voice concludes:

"...for then we would know the mind of God."

This is the final scene of the movie version of Stephen Hawking's A Brief History of Time (Paramount, 1993).[1] In the scene, Hawking reads from the book's concluding paragraph -- the now well-known "mind of God" passage. The scene and quotation demonstrate the use of religious imagery in the popular

[1] The excerpt represents my description of the final scene.

presentation of cosmology. Often, the public receives descriptions of cosmology in terms of religious language, metaphors, and images similar to Hawking's "mind of God." Part of the reason for these religious appeals may simply be to increase sales (Miller, 1994, 50). However, in this thesis, I argue that the appeals to religion in popular mediums do more than just increase the sales of books, magazines, and newspapers. The religious language, metaphors, and images present a particular model, or picture, of cosmology to the public -- a model I will call "cosmology as religion." Further, this model helps legitimate cosmology by appropriating religious authority which strengthens arguments justifying society's continued support of cosmology. This study looks at a particular medium of popularized cosmology: books written by cosmologists and intended for a lay audience. The primary texts of this thesis include Hawking's *A Brief History of Time*, published in 1988, and other, more recent works (see *Primary Sources* below).

In this chapter, I briefly discuss the common misconception that the history of the relationship between science and religion consists only of conflict and tension. Following this, I introduce the primary texts and review the relevant secondary literature. Chapter 2 examines the religious language, metaphors, and images in the texts. Through the use of religious imagery to describe cosmology, the authors' create new, scientific-religious images, such as the "cosmologists as priests" metaphor, which give cosmology and cosmologists traditional religious roles.[2] Taking the scientific-religious imagery from all the texts produces a model of cosmology as religion in the sense that cosmology performs religious functions.[3] Individually, some of the texts present a stronger picture of cosmology as religion than others, but all of them contain elements of the model. In Chapter 3, I discuss the non-religious imagery (e.g., cosmology as a detective story) in the texts, paying special attention to Steven Weinberg, who

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[2] By traditional religious roles, I mean functions that society generally expects religion to perform. These functions include providing meaning and purpose to life, access to God, and spiritual leadership. For the most part, people expect religion, not science, to fulfill these roles.

[3] The term model is used to describe the image or overall picture of cosmology presented to the public through the religious appeals in the texts. In the sense that the model of "cosmology as religion" puts forth a set of beliefs and ideas about the functions and nature of cosmology, the model also encompasses an ideology of cosmology and physics.

argues against presenting cosmology in relation to God. For the most part, the non-religious imagery remains minor compared to the scientific-religious imagery, and it does not come together in a consistent model like "cosmology as religion." Further, despite Weinberg's arguments, his text creates scientific-religious imagery which gives cosmology in religious roles. Chapter 4 addresses the appropriation of religious authority and the justification of cosmology. Here, I draw on the work of Evelyn Fox Keller to illuminate the texts' appropriation of religious authority through the scientific-religious imagery. In addition, I present the authors' arguments justifying cosmology and appealing to society for continued support (i.e., funding). I argue that the texts link the justificatory arguments to the scientific-religious imagery. As a result, the appropriation of religious authority strengthens the arguments justifying cosmology to the public. Finally, Chapter 5 provides a brief summary of the thesis and its conclusions.

Science and Religion: The Myth of Conflict

The popular historical picture of science and religion is one of tension and conflict. Galileo's condemnation and the Darwinian conflict with creationism come easily to mind. The work of John William Draper and Andrew Dickson White at the end of the 19th century further reinforced this historical myth. The Draper-White interpretation holds that the early church worked against the development of modern science by stopping science or, at least, impeding its progress (Lindberg, 1986, 19-21).[4] Writing in the late 1800's, these authors projected the conflict sparked by Darwinism into the past (Westfall, 1958, 11-12).[5] While modern scholarship has begun to dispel this myth, the Draper-White interpretation remains prevalent in popular culture (Lindberg, 1986, 19-21).

Looking back, we often find science and religion allied, and many scientists actually studied nature for religious purposes. For example, 17th century English scientists, called the "virtuosi," used natural science to confirm their religious beliefs. In addition, their books often attempted to demonstrate God's presence in nature. In fact, many members of the Royal Society were clerics, and they

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[4] Lindberg cites (Draper, 1876) and (White, 1896).

[5] Westfall also mentions the writings of W. E. H. Leaky in addition to Draper and White.

easily reconciled the ministry with their natural philosophy (Westfall, 1958, 11, 17-18). Members of the Royal Society and, in general, 17th century mechanists, launched a campaign in the name of Christianity against pagan nature-worship (Midgley, 1992, 81). During the 18th century Enlightenment, many natural philosophers used Newtonian physics to support deists beliefs about God and nature (Jacob, 1986, 247). Deists hold that God created the universe and the laws of nature, but has since left the world to run according to those laws. As a result, God represents a master watchmaker or architect who designed and made the universe, and the study of nature reveals God's handiwork (Force, 1985, 39, 69). In the early 19th century, a large number of geologists held ecclesiastical positions without any personal conflicts between their scientific and religious views. These geologists did not tie their religious beliefs to literal interpretations of Scripture, and in their work, some tried to reveal to the public a sense of God's design in the physical world (Rudwick, 1985, 42-45). All these scientists/natural philosophers built upon a tradition established in natural theology which attempted to demonstrate God's existence and Providence based on the order, stability, and sense of design in nature. They studied nature as God's creation, and, as a result, they felt they learned about God through science.

Getting past the myth of conflict serves two purposes for this thesis. First, we can see the history of some of the imagery created in the primary texts. The texts present cosmology as learning about God in the physical world -- a concept with a long tradition in natural theology and present in the beginnings of modern science in the 17th century. Second, realizing that science and religion can complement each other, we should not be surprised that the religious imagery in today's lay literature does constructive work. Specifically, the imagery appropriates religious authority and strengthens the claims made to the public by the cosmologists.

Primary Sources

I analyze the following primary sources (see Bibliography for detailed references):[6]

- *The Origin of the Universe*, by John D. Barrow, 1994
- *The Mind of God: The Scientific Basis for a Rational World*, by Paul C. W. Davies, 1992
- *A Brief History of Time: From the Big Bang to Black Holes*, by Stephen W. Hawking, 1988
- *The God Particle: If the Universe is the Answer, What is the Question?*, by Leon Lederman with Dick Teresi, 1993
- *Wrinkles in Time*, by George Smoot and Keay Davidson, 1993
- *Dreams of a Final Theory: The Scientist's Search for the Ultimate Laws of Nature*, by Steven Weinberg, 1992

In general, the texts discuss cosmology in relation to "ultimate" questions and theories. Ultimate questions concern the origin and meaning of life and the universe -- "how and why the universe began and what is our place in it?" (WT: 2). Ultimate theories refer to a unified theory, or set of laws, which describes the universe in terms of elementary particles and interactions. Hawking refers to this as the theory of everything (TOE) while Weinberg calls it the final theory or final laws. Thus, the cosmological quest refers to the scientific pursuit towards the ultimate questions and final laws. Below, I introduce the primary texts and their authors.

Hawking, who remains confined to a wheelchair and communicates through a computer system and voice synthesizer (Hawking suffers from ALS (amyotrophic lateral sclerosis) also known as Lou Gehrig's disease), is perhaps the most famous scientist of our time. In *A Brief History of Time*, Hawking attempts to address the questions that led him to cosmology: "Where did the universe come from? How and why did it begin? Will it come to an end, and if so, how?" (BHT: vi). Hawking's main themes include the creation of the universe and the quest

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[6] The primary texts are cited by title abbreviation and page number (e.g., (OU: 17) for *Origin of the Universe*, page 17). The title abbreviations are OU, MG, BHT, GP, WT, and DFT respectively.

for a TOE. In the process, he describes big bang theory and his theoretical work on black holes and quantum cosmology.[7] Big bang theory runs into problems at the moment of creation. The theory predicts a mathematical point, called a singularity, where the universe possesses infinite mass and energy and the laws of physics break down. As a result, the standard big bang theory cannot explain the creation event -- the big bang itself. Quantum cosmology represents an attempt to get around this problem. Hawking describes how quantum cosmology, developed by Hawking and Jim Hartle, eliminates the singularity at the moment of the big bang. Hawking calls this the "no boundary" condition, meaning there is no singularity. According to Hawking, the TOE, or final theory, will give us the set of laws that govern everything in the universe, including our existence (BHT: 168). Hawking claims such a theory is the goal of science, and he believes the study of the early universe might unify the two theoretical systems of contemporary physics (quantum mechanics and relativity), producing a final theory in our lifetime (BHT: 10, 167). Basically, in his text, Hawking attempts to explain cosmology and his own work to the reader.

Smoot's text discusses the Cosmic Background Explorer (COBE) satellite's discovery of variances in the cosmic microwave background radiation (CMB). Smoot's title, *Wrinkles in Time*, refers to these variances, also called the CMB anisotropy. Smoot was the principal investigator of the differential microwave radiometers (DMR) group -- one of COBE's experiments. The DMR detected the variances. This anisotropy in the CMB represents structures in the early universe, 300,000 years after the big bang, that eventually produced the matter distribution we observe in the universe today. COBE helps solve a long standing problem of big bang cosmology: how could the highly structured universe we observe today evolve from smooth, isotropic early universe? Before COBE, measurements of the CMB suggested an even distribution of matter in the early universe. Extrapolating this to the present, a smooth universe would not contain galaxies, galaxy clusters and superclusters (i.e., clusters of galaxy clusters), or us. As a result, an uneasiness grew in the scientific community about big bang theory that COBE put to rest. In fact, Stephen Hawking described the COBE

[7] See (Peebles, 1993, 3-10) for an introduction to big bang theory.

results as "the discovery of the century if not of all time" (Miller, 1994, 446-447, 450). COBE's discovery does not tell us *how* the anisotropy developed into the matter distribution of the current universe, but it eliminated concerns over the smoothness of the early universe.

The Superconducting Super Collider (SSC) represents a major theme in Lederman's and Weinberg's texts (Kevles, 1995, xv-xvi).[8] A proposed $5.9 billion dollar project (which grew to $11 billion by 1993), the SSC would have been the largest, most powerful particle accelerator in the world. According to Daniel J. Kevles, the post-World War II drive in accelerator research was symbiotically tied to high energy physics' (HEP) development of the Standard Model. According to this model, all matter consists of quarks and leptons, which are represented as fields. These fields interact with one another through the exchange of particles. Some of these exchange particles are very massive, and it takes high-energy interactions to produce them (since mass is equivalent to energy).[9] As a result, physicists use accelerators to create high-energy reactions capable of studying these massive particles. To test theories and further explore the Standard Model, physicists have built accelerators with increasingly higher energies (Kevles, 1995, xi, xiv).

The push for the SSC underscores developments in unification theories. The Standard Model attempts to cover three of the four fundamental interactions: electromagnetic, weak nuclear, and strong nuclear (gravity is the fourth). In 1967, Weinberg developed an electroweak theory unifying the electromagnetic and weak nuclear interactions. Abdus Salam independently came up with the same ideas in 1968, and Weinberg, Salam, and Sheldon Glashow shared the 1979 Nobel Prize for this theory (Weber, 1988, 261-262). The theory states that

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[8] Kevles discusses the current trend in the popularization of particle physics and cosmology towards "quasi-religious treatises." Here, authors frequently invoke religious and spiritual images to describe scientists and science. Particle physics enters cosmology and this trend through particle theories of the early universe. Kevles specifically cites Lederman's text, *The God Particle*, and Steven Weinberg's *Dreams of a Final Theory* (Kevles argues Weinberg's text avoids the quasi-religious trend). To bring cosmology's link with particle physics to this thesis, both texts have been included in the primary sources.

[9] For example, the W^+ and W^- exchange particles both have masses of 80.2 GeV while the Z^0 has a mass of 91.2 GeV (the mass of a proton equals 0.938 GeV).

the two interactions display a symmetry at high energies, acting as a single electroweak interaction. Relating this to the big bang, the electroweak symmetry existed in the high energies of the early universe, but when the universe cooled to a certain temperature, the symmetry was broken and the two interactions became distinct at the lower energies we observe in the current universe. The electroweak theory predicted three particles which mediated the interactions between the electromagnetic and weak nuclear interactions. CERN, a European accelerator, produced these particles in 1983. Physicists believe the Higgs field, mediated by the Higgs particle, plays a role in the electroweak symmetry breaking and determines the masses of the particles mediating the electromagnetic and weak interactions. According to theory, the energies reached by the SSC would produce the Higgs particle (Kevles, 1995, xiv-xvi).

Grand Unification Theories (GUTs) attempt to unify the electroweak and strong interactions, postulating another symmetry at even higher energies. This means the GUT symmetry breaking took place closer to the big bang than the electroweak breaking. GUTs have been applied to big bang cosmology, and in the early 1980's, several groups showed GUTs might solve some problems concerning the evolution of the early universe (Kevles, 1995, xiv-xvi). However, these theories leave out the fourth fundamental interaction: gravity. When the primary texts refer to a theory of everything (TOE) or final theory, they mean a theory which incorporates all four interactions.

Lederman lobbied and testified before Congress as one of the SSC's primary advocates. Weinberg also participated in Congressional debates (Kevles, 1995, xvi, xvii). In both their texts, the authors lay out their arguments for the SSC. Lederman, an experimental physicist, focuses his arguments upon discovering the Higgs particle, while the theoretical physicist, Weinberg, emphasizes the SSC's importance to the quest for a final theory. Lederman has been doing accelerator research since the 1950's. He served as director of Nevis Laboratories at Columbia University from 1962-1979 and as director of Fermilab from 1979-1989. In addition, he won the Nobel Prize in 1988 with Melvin Schwartz and Jack Steinberger for experimental work involving neutrinos.[10] In

[10] Neutrinos are neutral particles that travel at the speed of light and rarely interact with other matter.

his text, Lederman traces the history of particle physics and the development of the Standard Model, emphasizing experimental research and accelerators. Lederman focuses on HEP's need to produce the Higgs particle, which he names the 'God particle.' Weinberg, on the other hand, argues that whether the SSC finds the Higgs or not, HEP needs the SSC to continue its search for a final theory. Despite their efforts, however, the House of Representatives terminated funding for the SSC in October of 1993 (Kevles, 1995, xvii).

Barrow, a Professor of Astronomy at the University of Sussex, England, has written several books on cosmology. In *The Origin of the Universe*, Barrow tries to provide an introductory description of contemporary cosmology, including the evolution of the universe according to the standard big bang theory and what cosmological models say about our existence. Barrow touches upon several themes of the other texts. Barrow presents current theories about the creation of the universe, including the quantum cosmology of Hawking and Hartle. Barrow also discusses COBE and its significance to cosmology. Finally, Barrow describes cosmology as a convergence of HEP and astronomy as physicists move toward a better understanding of our universe.

Unlike the other authors, Davies specifically addresses cosmology and religion in *The Mind of God* (Davies' title refers to Hawking's concluding passage discussed above). Davies is a physicist who has written numerous books on cosmology and previously addressed the relationship between cosmology and religion in *God and the New Physics* (Davies, 1983). In fact, Davies won the 1995 Templeton Prize for Progress in Religion in recognition of his work concerning the relationship between science and religion. According to Davies, contemporary cosmology addresses issues that once resided in the domain of religion (e.g., the origin of the universe and the nature of time) (MG: 13-14). Davies acknowledges that the ultimate questions (i.e., questions addressing the origin and meaning of life and the universe) lie outside the usual definition of science, but he argues we need science to understand these "really deep issues of existence" (MG: 15, 20-21). In his text, Davies compares cosmological and theological theories of creation, and he discusses what these creation theories imply about God as a creator. Further, he explores what cosmology's study of the physical universe can tell us about God, concluding that nature displays

transcendent qualities (e.g., ingenuity, economy, beauty) that might represent a deity (MG: 214). Davies also discusses the laws of physics and mathematics, arguing that the laws have an existence independent of the physical universe (MG: 84). Below, we will see many of these themes -- that cosmology addresses the ultimate questions, that cosmology provides knowledge about God, and that the laws of physics transcend the physical universe -- echoed in the texts through their use of religious imagery.

Who are the audiences for these texts? Who receives the model of science created by the religious appeals? Hawking's text enjoyed phenomenal success, spending 100 weeks on the bestseller lists in 1988 and 1989 (Nixon, 1991, 32). By 1992, estimated sales equaled two million for U. S. and Canada and over four and a half million world-wide (Rogers, 1992, 231). As a result, this text reached a much wider audience than the others. However, the science book industry enjoys a consistent readership, and cosmology and physics generally sell better than other sciences, representing the only disciplines that seem to do well in their pure forms (Nixon, 1991, 32, 33). In addition, since Hawking's success royalty advances have increased, especially for eminent scientists (Rogers, 1992, 233) (Nixon, 1991, 32-33). This suggests that popular science books have sold well since *A Brief History of Time*. The readership probably consists mostly of college educated individuals interested in science, but with other careers (Nixon, 1991, 32, 33). In addition, some of the primary texts have another audience: Congress. Weinberg writes, "I had the surreal experience of hearing senators on the floor of the Senate arguing about the existence of Higgs bosons, and quoting this text [i.e., *Dreams of a Final Theory*] as an authority" (DFT: 277). Lederman's text surely found its way into the hands of senators and representatives as well. These groups receive the model of "cosmology as religion." Further, as we will see in Chapter 4, the authors attempt to justify cosmology to this audience, appealing to them (including Congress) for financial support.

Secondary Literature

A survey of secondary literature has not revealed any work focusing directly on religious appeals in popularized cosmology, the model of cosmology the scientific-religious imagery presents to the public, or how that model legitimates arguments justifying society's support of cosmology. However, a significant amount of scholarship addresses issues related to this study. Below, I summarize the secondary literature based on some general categories. Mary Midgley's *Science as Salvation* and James F. Moore's "Cosmology and Theology: The Reemergence of Patriarchy" especially address issues raised by this thesis.

In *Science as Salvation*, Midgley offers some examples of cosmology performing religious functions. Midgley discusses a cosmological project speculating about the future of humanity. According to Midgley, this project began in 1929 with the work of J. D. Bernal and continues today in the work cosmologists like Barrow, Frank J. Tipler, and Freeman Dyson. In general, the project involves predictions that, through science, future humans will live forever as biomechanical (human-computer) hybrids or non-corporeal life such as dust clouds or plasma. Midgley argues these predictions explain the purpose of the universe and human existence as the continual accumulation of information. In this scenario, humans, now machines or dust clouds, expand throughout the universe(s) and reach the Omega Point -- the point of ultimate, complete knowledge. Midgley claims that these cosmologists offer science as providing meaning and purpose to life and a path to eternal life -- topics traditionally handled by religion. In other words, science offers salvation (Midgley, 1992).

The primary texts of this thesis, including Barrow's *The Origin of the Universe*, do not involve Bernal's project. However, Midgley raises some issues that occur in the texts' scientific-religious imagery. Midgley quotes Davies as saying that science offers a surer path to God than religion, and she argues that Peter Atkins attributes to Chaos many roles formerly held by God (Midgley, 1992, 45, 135, 178).[11] In the primary texts, Davies and the other authors present cosmology as offering access to God and divine knowledge. In addition, like

[11] Midgley quotes from (Davies, 1983).

Atkins, the authors give the laws of physics God-like functions and qualities, creating an image of laws as God. Finally, Midgley claims that Hawking refers to purpose when he discusses cosmology as addressing questions like 'why are we here?' (Midgley, 1992, 7-8). The idea that cosmology provides meaning and purpose to life represents another common theme in the texts. Midgley's study looks at cosmological texts up to and including Hawking's *A Brief History of Time* -- the starting point of this thesis. As a result, the following study expands on these issues raised by Midgley (except for Bernal's project), exploring their occurrence in more recent popular writings.

Moore also addresses themes shared by this thesis. Moore argues the quasi-theological ideas in the work of cosmologists represent new versions of traditional, so-called "patriarchal" ideas (Moore, 1995, 613). According to Moore, the texts present a patriarchal view of God which gives God complete control of the universe. With God as the center of power, math and logic -- the laws of nature -- become closely related to divine power. As a result, Moore claims the laws reflect God's reality in nature (Moore, 1995, 617). Moore's analysis includes two of the primary texts: *The Mind of God* and *A Brief History of Time*. Moore claims that Davies approximates the patriarchal view of a transcendent God, holding ultimate power within the laws of physics and math. Mathematics, then, is the mind of God, and science represents the best road to God (Moore, 1995, 620). In addition, Moore argues that Hawking's claim that a TOE would enable us to know the mind of God identifies God with an abstract mathematical structure which governs the universe. This, Moore believes, reduces God to the interactions in the TOE. Again, the laws of physics reflect God (Moore, 1995, 621-622). Moore's analysis, then, ties closely to a recurring theme in this study which Midgley also discusses: the primary texts present the laws of physics as God and cosmology as providing access to that God.

Let us move to the various kinds of secondary sources. The first involves the theoretical (i.e., epistemological, ontological, and methodological) content of science and/or religion. The relationship between science and religion as well as comparisons of scientific and theological theories or methods represent common topics in this category. Although Midgley's and Moore's studies are closely related to this thesis, they fall under this category. Midgley discusses how

cosmological claims address traditional religious issues of salvation and eternal life, but the text focuses more on the philosophical foundations (e.g., materialism, teleology) behind the claims (Midgley, 1992). Similarly, Moore's study looks at patriarchal foundations behind the conceptions of God in popular science texts (Moore, 1995). This category also includes other articles that discuss the primary authors. George W. Shields critically examines Davies' work from a philosophical point of view in hopes of furthering the dialogue between physicists and theologians. Shields presents the design arguments of such philosophers as Swinburne and Hartshorne in comparison to cosmological arguments against design discussed by Davies (Shields, 1994). In another article, Robert J. Deltete examines Hawking's statements about God, arguing against Hawking's theological conclusions (Deltete, 1995).

The other three categories are narrower than the first, and they deal with the relationship between science and the public. First, a body of work focuses on popular culture's image of science. Christopher P. Toumey examines how several types of creationism relate to different cultural models of science in America, arguing that the success of scientific creationism results from the appropriation of scientific authority (Toumey, 1991). Other examples include George Basalla's study of popular images of science and technology presented in public forums such as novels, cartoons, and movies. Basalla claims that these mediums often present physicists as unemotional and potentially dangerous to themselves and society (Basalla, 1976). A closely related category involves science in the media. Of specific interest, Steven Miller surveys media coverage of COBE's discovery of the CMB anisotropy, examining how the media presents cosmology to the public. Miller argues the print media was sensitized to issues concerning cosmology and religion because of cosmologists, including Hawking and Davies, that used questions of God and religion to popularize their work. This, Miller claims, explains the media's fixation on Smoot's press conference statement: "If you're religious, it's like seeing God" (Miller, 1994). The final category contains studies of popular science literature. Examples include the work of Baudouin Jurdant and Martin Eger. Jurdant explores popular science texts, claiming that the text's truth claims distinguish popular science books as a literary genre (Jurdant, 1993). Eger believes that a new genre of science books

exists. This genre includes popular texts which explore deeper meanings of science in relation to questions of human understanding (Eger, 1993). Eger's genre would include the primary texts.

This literature addresses many aspects of the following thesis. However, these studies differ in focus from my current project. This thesis, instead, concentrates on the model of cosmology created by the religious appeals and presented to the public, and how these appeals appropriate religious authority and strengthen the authors' justificatory arguments. I begin with the textual analysis of the scientific-religious imagery created in the texts, arguing the texts present a model of "cosmology as religion" to their lay audience.

CHAPTER 2: Scientific-Religious Imagery

This chapter represents the textual analysis of the scientific-religious imagery presented in the primary texts. The authors' use of religious language, metaphors, and images gives cosmology and cosmologists religious and spiritual dimensions. The texts create new, scientific-religious imagery that gives cosmology traditional religious functions. For example, the authors discuss the laws of physics in relation to God and present cosmologists as priests who act like a scientific clergy. Further, we see images of cosmologists that have access to the "mind of God" through the laws of physics as well as instruments and machines. This creates an image of cosmologists as spiritual leaders, seeking divine knowledge on behalf of a lay public. In addition, the texts offer cosmology as providing meaning and purpose to our lives by defining humankind's place in the universe and supplying society with modern creation myths. Again, this gives cosmology religious functions. Finally, the authors' discussion of cosmology in relation to various theological issues asserts cosmology's ability to address theological concerns.

Through the scientific-religious imagery (e.g., cosmologists as priests) the texts give cosmology and cosmologists religious roles. In this sense, the texts present a model, or picture, of cosmology that functions like a religion. The authors create a model of Cosmology-*as*-Religion. This chapter details how the texts create this model.

Laws and God

Three images of laws and God emerge from the texts. First, the authors present the laws as representing God's design or creation. These are Laws-*of*-God. Next, laws restrict God's choices and actions -- Laws-*on*-God. Finally, the texts grant laws God-like abilities and qualities. Here, the texts present Laws-*as*-God. Looking back, we can find the idea that the laws of nature relate to God in 17th century scientific thought. Francis Oakley and John R. Milton argue that 17th century scientists like Boyle, Descartes, and Newton developed the conception of scientific laws from the prominent theological doctrine of a free and omnipotent God, completely independent from the physical world. Such a God

imposes laws on nature from outside the physical universe. Thus, these scientists conceived of regularities in nature as laws imposed by God (Oakley, 1961) (Milton, 1981).[1] This corresponds to Laws-*of*-God with scientists studying God's work via the laws of physics. Milton argues that by the middle of the 18th century, if not before, the concept of scientific laws gained widespread acceptance and no longer needed the support of its theological foundations (Milton, 1981, 195). Similarly, Oakley claims the modern conception of scientific laws, referring to mathematical or statistical regularities in the physical world, lacks any reference to God's command or will (Oakley, 1961, 450).[2] However, this is not the case in today's popular literature, and we find several images of laws and God in the primary texts.

Representation: Laws-*of*-God

The texts present the image of Laws-*of*-God. By this I mean that, according to these texts, the laws of physics represent God's design or creation. This also implies that the study of nature reveals knowledge about God, making cosmology a means to divine knowledge. Sometimes, the authors specifically refer to a Creator or Lawgiver. In other passages, the language used implies the laws come from God.

Lederman's text consistently presents science as discovering laws about God's creation. His "Very New Testament," a rewrite of Scripture, includes several references to God and the universe as God's creation (see Appendix A for the complete Very New Testament):

> And the Lord sighed and said, Go to, let us go down, and there give them the God Particle so that they may see how beautiful is the universe I have made.

---

[1] For a different interpretation of the origin of scientific laws, see (Ruby, 1986). Ruby traces the development of laws in three fields, and she argues that the idea of laws imposed by God only influenced one of the fields of development -- the field involving Descartes (Ruby, 1986, 342, 357-358). Despite the origin of the concept of scientific laws, however, scientists like Descartes and Boyle conceived of the laws as imposed by God.

[2] Part of this shift, which Oakley does not address, reflects a change from the deterministic laws of classical physics to quantum mechanics' use of probability and statistical regularities into the laws of physics.

(GP: 24)

> And the Lord looked upon the world She had created and She saw that it was also boring. So She computed and She smiled and She caused Her universe to expand and to cool. And lo, it became cool enough to activate Her tried and true agent, the Higgs field...
>
> (GP: 342)

Lederman refers to God as the creator and governor of the universe. Further, the Higgs particle represents God's divine agent. Thus, physics seeks to describe God's creation through the laws of physics (e.g., finding the Higgs particle will tell us how God created the universe (GP: 376)). In addition, Lederman presents the image of God setting the values of the constants of nature, stating "If a vengeful Creator could make [the gravitational constant] equal to zero, life would end pretty quickly" (GP: 94-95). All this serves to present an image of the laws of physics representing God's design.

Weinberg and Hawking present a similar conception of laws. Consider the following quotation from Weinberg:

> If there were anything we could consider in nature that *would* give us some special insight into the handiwork of God, it would have to be the final laws of nature. Knowing these laws, we would have in our possession the book of rules that governs the stars and stones and everything else.
>
> (DFT: 242)

Thus, the laws of physics are the "handiwork of God" -- God's rules for the universe. Later, Weinberg writes:

> If, on the other hand, we found some special role for intelligent life in the final laws..., we might well conclude that the creator who established these laws was in some way specially interested in us.
>
> (DFT: 251)

Here, Weinberg specifically refers to God as a lawgiver -- "the creator who established these laws." Weinberg does not believe the final laws will reveal a special status for life or anything about God (see pp. 56-59). However, these passages still present the image of laws established by God.

Hawking also discusses the Laws-*of*-God. In the following passage, he writes that cosmology discovers laws that may come from God:

> Science seems to have uncovered a set of laws that, within the limits set by the uncertainty principle, tell us how the universe will develop with time, if we know its state at any one time. These laws may have originally been decreed by God, but it appears that he has since left the universe to evolve according to them and does not now intervene in it.
>
> ...
>
> The whole history of science has been the gradual realization that events do not happen in an arbitrary manner, but that they reflect a certain underlying order, which may or may not be divinely inspired.
>
> (BHT: 122)

Hawking does not state that God made the laws of physics, but suggests this may be the case. In fact, he claims the entire scientific endeavor leads to the conclusion that the laws reflect an underlying order which may be "divinely inspired." Since Weinberg argues against the final laws' ability to reveal God's handiwork and Hawking only suggests the laws might come from God, their imagery is weaker than Lederman's. Actually, Lederman's humorous style leads to bold imagery in passages like the "Very New Testament." In any case, Weinberg's and Hawking's statements still allow for the idea that science uncovers laws handed down by God.

Other passages present laws in similar ways, but do not specifically refer to a designer or creator. Often, the wording implies the laws come from a transcendent source (i.e., outside and independent of the physical universe). For example, the statements that humans "have been written into the laws of nature" (MG: 21), that the laws provide explanations of "necessit[ies] built into nature" (DFT: 9), and that the universe's evolution "was written in its beginnings - in its cosmic DNA..." (WT: 296) imply a cosmic writer or builder that emulates the designer God discussed above. Lederman refers to equations as "both the Ouija board and the Rosetta Stone" (GP: 19), implying that the laws of physics give us access to the transcendent and the ability to decipher it. Finally, Davies writes:

> As I have explained at length, creation cannot consist of merely causing the big bang. We are searching instead for a more subtle, timeless

> notion of creation which, to use Hawking's phrase, breathes fire into the equations, and thus promotes the merely possible to the actual existing. This agency is creative in the sense of being somehow responsible for the laws of physics, which govern, among other things, how space-time evolves.
>
> Naturally the theologians argue that the creative agency that provides an explanation for the universe is God. But what sort of agency would such a being be?
>
> (MG: 171)

Davies does not claim this agency represents God, but his image of agency possesses God-like abilities. Specifically, the agency represents a transcendent force that creates, or at least is "responsible for," the laws of physics. In this sense, Davies presents a Laws-*of*-God image.

These passages present the laws of physics as representing God's design and creation. Some passages explicitly state that God or another transcendent agency established the laws. Other times, the authors' discussions imply the laws come from God through the use of passive voice (e.g., the laws have been written or built into nature). This removes the physicists from the creation of the laws and implies they come from someplace else. Specifically, the texts suggest the laws come from a God-like cosmic builder or designer. As a result, cosmology learns about this transcendent, creative force by discovering the laws, and cosmology becomes a means to learn about God. In addition, this places cosmologists in the role of priests, both learning about God and interpreting God's design or message through the laws of physics. Representing God's message, the laws function as Scripture.

Restriction: Laws-*on*-God

In other areas of the texts, laws *restrict* God. In this case, the laws of physics limit God's actions and choices. Laws-*on*-God makes God subject to logic and the laws of physics, and it tends to appear in discussions about why our universe displays the laws that it does or whether our universe could be different.

Restriction imagery appears often in Hawking's text, and he writes about the laws of physics placing requirements on God's actions. For example, Hawking

claims that "an expanding universe does not preclude a creator, but it does place limits on when he might have carried out his job!" (BHT: 9). Similarly, in the following passage, Hawking discusses restrictions on God's choices regarding the laws of physics:

> Einstein once asked the question: "How much choice did God have in constructing the universe?" If the no boundary proposal is correct, he had no freedom at all to choose initial conditions. He would, of course, still have had the freedom to choose the laws that the universe obeyed. This, however, may not really have been all that much of a choice; there may well be only one, or a small number, of complete unified theories, such as the heterotic string theory, that are self-consistent and allow the existence of structures as complicated as human beings who can investigate the laws of the universe and ask about the nature of God.
>
> (BHT: 174)

First, the no boundaries proposal[3] restricts God's choice in selecting the universe's initial conditions.[4] In addition, Hawking claims that the mathematical and logical requirements for a "self-consistent theory" further limit God's choices in selecting the laws of physics. In other words, God's choices depend on the logic and mathematical relationships of the laws. Thus, Hawking asserts the laws' authority over God.

With a similar theme, Davies examines several theories of the universe as a logical necessity (i.e., the universe *has* to be the way that it is due to logical constraints) in relation to God's choices. In fact, Davies cites the Hawking passage above in the following paragraph:

> Is it possible that the laws of our universe, while not logically unique, are nevertheless the only possible laws that can also give rise to complexity?

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[3] The no boundary proposal refers to the quantum cosmology which eliminates the big bang singularity (see pp. 5-6).

[4] It takes both laws and initial conditions to describe a physical system. For example, we can use Newtonian laws of motion to calculate a planet's position, but we need certain initial conditions to plug into the equations (e.g., the position of the planet relative to the sun at a given time). The laws remain constant, but initial conditions change (e.g., different planets in different orbits). However, the cosmic initial conditions describe the initial state of the universe, and do not change since they only apply to one situation, our universe.

> Perhaps our universe is the only possible one in which biology is permitted, and hence in which conscious organisms could arise. This would then be the only possible *cognizable* universe. Or, to return to Einstein's question about whether God had any choice in his creation, the answer would be no, unless he wanted it to go unnoticed.
>
> (MG: 167-168)

Davies then quotes the last sentence of the Hawking passage (see (BHT: 174) above). So, Davies also speculates if only one set of laws allows conscious life, then God would not have any choice in creating our universe (i.e., a universe with conscious beings). Again, this grants the laws of physics, mathematics, and logic authority and control over God. As a result, the laws restrict God's actions, creating the image of Laws-*on*-God.

By restricting God's actions with the rules of logic and mathematics, the texts assert the authority of laws over God. As a result, through Laws-*on*-God, the texts give laws God-like abilities since laws represent the supreme authority over the creation and governance of the universe. Cosmologists, then, function as priests who discover and reveal knowledge about the laws of physics -- *the* supreme, all-powerful agency that rules the universe.

Replacement: Laws-*as*-God

Finally, the texts present an image of Laws-*as*-God. Here, the laws of physics replace God. This imagery operates on two levels: laws directly assume God-like functions, and the authors use language that gives laws God-like properties.

Hawking uses the laws of physics to replace God as a creator and governor of the universe. In the following passage, Hawking discusses the quantum cosmology that he and James Hartle developed:

> The idea that space and time may form a closed surface without boundaries also has profound implications for the role of God in the affairs of the universe. With the success of scientific theories in describing events, most people have come to believe that God allows the universe to evolve according to a set of laws and does not intervene in the universe to break these laws. However, the laws do not tell us what the universe should have looked like when it started -- it would still be up

> to God to wind up the clockwork and choose how to start it off. So long as the universe had a beginning, we could suppose it had a creator. But if the universe is really completely self-contained, having no boundary or edge, it would have neither beginning nor end: it would simply be. What place, then, for a creator?
>
> (BHT: 140-141)

First, the laws of physics replace God's governance of the universe; the laws dictate the evolution of the universe. Then, Hawking uses his quantum cosmology to write God (as a creator) out of existence by eliminating the creation event.[5] As a result, the laws assume these two functions: creation (through quantum cosmology's elimination of a creation moment) and governance of the universe.

Davies also directly places laws into God-like roles. First, he asserts that the laws of physics eliminate the need for theological explanations regarding physical systems (e.g., snowflakes and living organisms) (MG: 195). In addition, human thought processes, according to Davies, "are not God-given," but "depend on the laws of physics and the nature of the physical world we inhabit [i.e., evolutionary factors]" (MG: 23). Finally, Davies discusses his concept of laws as a cosmic blueprint:

> [The laws of physics] look *as if* they are the product of intelligent design. I do not see how that can be denied. Whether you wish to believe that they really *have* been so designed, and if so by what sort of being, must remain a matter of personal taste. My own inclination is to suppose that qualities such as ingenuity, economy, beauty, and so on have a genuine transcendent reality -- they are not merely the product of human experience -- and that these qualities are reflected in the structure of the natural world. Whether such qualities can themselves bring the universe into existence I don't know. If they could, one could conceive of God as merely a mythical personification of such creative qualities, rather than as

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[5] The Hawking-Hartle quantum cosmology eliminates the big bang singularity (see pp. 5-6). Therefore, the universe does not have a defined creation event which, to Hawking, eliminates God's role as a creator. Quantum cosmology is a speculative theory without experimental evidence to support it. However, Hawking's discussion presents laws (i.e., accepted theories) as replacing God's role in the creation of the universe through eliminating the creation event.

> an independent agent. This would, of course, be unlikely to satisfy anyone who feels he or she has a personal relationship with God.
>
> (MG: 214-215)

Davies starts out with Laws-*of*-God, stating the laws appear to result from an intelligent design. However, he then moves into a Laws-*as*-God image. Davies offers aesthetic qualities as God. First, the laws transcend the universe. Next, if these qualities possess creative agency, they might be responsible for the universe's existence. Thus, the laws of physics, through their transcendent and creative qualities, replace God as the creator.

Barrow also presents the laws, through mathematics and logic, as God. In a section concerning the no boundary quantum cosmology of Hawking and Hartle and other quantum cosmologies of creation out of nothing, Barrow writes:

> All these theories need to assume at the outset the existence of a good deal more than one's everyday conception of "nothing" in order to say anything of interest. In the beginning, there must exist laws of nature..., energy, mass, geometry; and, of course, underpinning everything seems to be the ubiquitous world of mathematics and logic. There needs to be a considerable substructure of rationality before any complete explanation for the universe can be erected and sustained. It is this underlying rationality that most modern theologians emphasize when questioned about the role of God in the universe. They do not regard the Deity as simply the Great Initiator of the expansion of the universe.
>
> (OU: 110)

Barrow states that mathematics and logic make up the "underlying rationality" that modern theologians point to in order to demonstrate God's role in the universe. In other words, math and logic function like God regarding the governance and creation of the universe. This grants laws God-like abilities.

Besides direct replacement, the language in the texts places laws in God-like roles. For example, Davies writes "the laws permit matter and energy to self-organize into an enormous variety of complex states, including those that have the quality of consciousness, and can in turn reflect upon the very cosmic order that has produced them" (MG: 21). In other words, the laws of physics allow for the development of life. Similarly, according to Hawking, the laws of physics "govern the universe and are responsible for our existence" (BHT: 168). Davies

states the laws "govern, among other things, how space-time evolves" (see (MG: 171) on pp. 18-19). Weinberg also presents laws that govern "the stars and stones and everything else" (see (DFT: 242) on p. 17) and "govern" the evolution of the universe and all physical phenomena (DFT: 34, 147). In these phrases, laws fulfill the roles of creating life and governing the universe, assuming these God-like functions.

The texts also grant the laws of physics God-like qualities. Davies specifically discusses several qualities of scientific laws. He writes, "Curiously, the laws have been invested with many of the qualities that were formally attributed to the God from which they were once supposed to have come" (MG: 82). Davies then presents four God-like characteristics: laws are universal (i.e., they apply to all space and time), absolute (i.e., independent from anything else), eternal, and omnipotent (i.e., nothing escapes them) (MG: 82-84).

In addition, the texts often discuss laws as if they transcend the physical universe, another quality often attributed to God.[6] Lederman writes:

> We are convinced (though we cannot prove this) that only one sequence of events, played backward, can lead via the laws of nature from our observed universe to the beginning and "before." The laws of nature must have existed before even time began in order for the beginning to happen.
>
> (GP: 401)

Lederman argues that the laws transcend the universe, existing before the big bang. In addition, like the quotes discussed above, this passage also suggests that laws serve the functions of governance and creation of the universe. Davies describes the laws of nature and cosmic initial conditions as "given" (i.e., scientists cannot choose them; they have an independent existence) (MG: 87-88). Weinberg describes string theory as being discovered long before anyone knew what it was, implying laws exist independent of the physical world (DFT:

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[6] Davies also notes how the language used to describe laws implies they transcend the physical world, waiting to be discovered (MG: 82-84). This is closely linked to Davies' concept of absolute laws independent from anything else.

213).[7] In this way, the authors present laws as independent and transcendent of the physical universe, adding to their God-like qualities.

The texts present the laws of physics as God by giving laws the God-like functions of creating and governing the universe. In addition, the authors use language that puts laws in these roles and others, including the creation of life. Finally, the authors also give laws other God-like characteristics, reinforcing the Laws-*as*-God imagery. As with Laws-*of/on*-God, Laws-*as*-God creates an image of cosmologists as priests. In this case, however, the cosmologists enjoy direct access to God as the laws of physics.

Summary

The texts present a layered conception of the laws of physics and God. Laws move from representation to restriction and replacement, from laws as God's creation to laws over God and laws as God. Granting laws God-like abilities or authority over God, the texts give the laws of physics control over the creation and evolution of life and the universe. In addition, laws acquire other God-like qualities, transcending the physical universe. With the move from representation to restriction and replacement, the role of the cosmologists shifts as well. Cosmologists studying laws that represent God's message function like priests interpreting Scripture. However, Laws-*as*-God implies a more intimate relationship. Cosmologists have direct contact with God (i.e., the laws of physics) and deliver God's message (i.e., scientific knowledge) to the rest of society. In a sense, the cosmologists speak for God, writing Scripture instead of just interpreting it. Similarly, with Laws-*on*-God, cosmologists bypass the God of religion, providing knowledge about *the* ultimate power over God and the universe (I discuss the metaphor of cosmologists as priests in more detail

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[7] According to Weinberg, string theory represents a quantum theory of gravity and a possible final theory (DFT: 212). However, as Weinberg states, the theory does not yield any observational predictions (DFT: 218). Work in string theory, then, has proceeded purely on mathematical and theoretical grounds as physicists attempt to form a consistent mathematical scheme that incorporates general relativity and quantum mechanics. This would produce a final theory which describes all four forces of nature (see pp. 7-8). In light of this, Weinberg's statement implies that mathematics and the laws of physics as pure abstractions (not just mathematical regularities in nature) have an independent existence.

below). In addition, the metaphors of restriction and replacement assert science's superiority over religion. Since the laws of physics restrict or replace God, science supersedes religion.

Cosmologists as Priests

> I have always thought it curious that, while most scientists claim to eschew religion, it actually dominates their thoughts more than it does the clergy.
>
> Fred Hoyle
>
> (MG: 223)

This epigraph appears in the last chapter of Davies' text and shows another common image presented in the texts -- Cosmologists-as-Priests. We saw that the laws and God imagery places cosmologists in priestly roles. Beyond this, The texts develop this image in several ways. The authors compare cosmologists to priests and present them as spiritual men and women. Further, research becomes a mystical and revelatory experience. The texts also present images of cosmologists as martyrs while other passages assign cosmologists God-like abilities, strengthening the mystical and spiritual dimensions of the cosmologists. This section presents the imagery that creates Cosmologists-as-Priests, demonstrating how these images give cosmologists priestly functions.

Scientific Clergy

The texts often compare cosmologists to priests, like Davies' epigraph from Fred Hoyle cited at the beginning of this section. In addition, the authors discuss cosmologists as concerned with spiritual and theological issues. In both instances, the texts present cosmologists as spiritual men and women, functioning like priests. Regarding a 1987 "face of God" type conference, Lederman writes:[8]

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[8] This refers to Smoot's statement at a COBE press conference in 1992. Discussing the results, Smoot said, "If you're religious, it's like seeing God." Smoot discusses this quote in *Wrinkles in Time*, stating this statement should be taken metaphorically (WT: 289). Lederman refers Smoot's statement at the press conference although he misquotes it as "It was like seeing the

> What I enjoyed most was Hawking's summary talk on the origin of the universe, given Sunday morning at about the same time when 16,427 other sermons on roughly the same subject were being delivered from 16,427 from pulpits around the nation.... Except that Hawking's talk was delivered through a voice synthesizer, giving it just that extra authenticity.
>
> (GP: 400-401)

Here, Lederman presents Hawking as a priest or minister. In addition, this passage also describes cosmologists as addressing the same topics that priests concern themselves with (e.g. the origin of the universe). Smoot also expresses this view, writing that "the question of 'the beginning' is as inescapable for cosmologists as it is for theologians" (WT: 189). In another passage, Lederman describes Nobel laureates as those "who had been anointed with Swedish holy water" and compares Newton to a list of other historical figures, including Jesus, Mohammed, Moses, and Gandhi (GP: 6, 86). These comparisons reinforce the Cosmologists-as-Priests image.

Finally, Smoot presents cosmology as a mystical calling when he discusses personal feelings and motivations toward his work. For example, he writes:

> Big bang theory was already dominant when I entered the field, but the process of the big bang -- its cataclysmic event, the creation of all matter, and the formation of the galaxies -- seemed almost mystical to me. I remember on more than one occasion contemplating the night sky and musing that the big bang seemed as hard to swallow as the image of Atlas supporting the world on his shoulders, causing earthquakes as he shifted position to gain temporary comfort -- perhaps even harder! Twenty years later, it can still seem mystical to me, not because it is unscientific, but because it represents something so important to the human psyche.
>
> (WT: 17)

Immediately following this passage, Smoot discusses big bang theory as a creation myth (see (WT: 17-18) on pp. 43-44). In this context, Smoot's personal interests in cosmology takes on spiritual dimensions. If big bang theory provides

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face of God" (GP: 400). For a further discussion of COBE and the British media coverage, see (Miller, 1994). Miller specifically discusses the media's frequent citation of Smoot's God quote.

a creation myth for society, then Smoot becomes the priest interpreting the myth and conveying the meaning of that myth to society. As a result, his "mystical" feelings take on the dimensions of a spiritual calling. In another passage, Smoot refers to the lure of cosmology, reinforcing the idea of cosmology as a calling (WT: 89).

Thus, the authors compare cosmologists to religious figures and present cosmologists and priests as dealing with similar issues. Further, Smoot discusses cosmology as a mystical calling which gives cosmologists religious and spiritual dimensions. Finally, according to the texts, cosmologists perform priestly functions like myth creation and interpretation (see *Meaning and Purpose* below for a further discussion of myth in the texts).

The Mind of God

As discussed above, Laws-*as*-God suggests cosmologists have direct access to God. The idea that cosmologists can know the "mind of God" reinforces this image, and again, places cosmologists in the role of priests, speaking for God.

Hawking's "mind of God" quotation in the final paragraph of *A Brief History of Time* expresses the idea that cosmologists can provide access to and knowledge of God. Many of the other authors refer to Hawking and this concept in their texts. In fact, Davies titled his text *The Mind of God*. Here is Hawking's passage:

> If we do discover a complete theory, it should in time be understandable in broad principle by everyone, not just a few scientists. Then we shall all, philosophers, scientists, and just ordinary people, be able to take part in the discussion of the question of why it is that we and the universe exist. If we find the answer to that, it would be the ultimate triumph of human reason -- for then we would know the mind of God.
>
> (BHT: 175)

In other words, cosmology may one day enable us to answer the ultimate questions. This puts cosmologists on a quest for God, giving them and their work religious dimensions. Cosmologists become the spiritual leaders on the

quest for God and answers to the ultimate questions. Further, this associates God with the laws of physics, implying Laws-*as*-God.[9]

The idea that cosmologists provide knowledge of God appears in the other texts as well. Smoot and Davies use epigraphs to immediately introduce this image. Smoot begins his first chapter with the following "Sufi creation myth:"

> I was a hidden treasure and desired to be known: therefore I created the creation in order to be known.
>
> (WT: 1)

This quotation links the creation of the universe with knowledge of God. Since cosmologists study the creation, they acquire knowledge of the Creator. Davies opens his text with Hawking's "mind of God" passage quoted above (MG: 7). Lederman ends his first chapter with a passage from Genesis and his Very New Testament. Lederman compares the construction of the SSC to building the Tower of Babel. Only this time, in the Very New Testament, scientists complete the tower and then, quoting Albert Einstein instead of Hawking, "know the mind of God" (GP: 23-24) (see (GP: 24) on pp. 74-75). Finally, Weinberg discusses Hawking's quote, noting the urge to use God metaphors because of physics' fundamental nature (DFT: 242).[10] Thus, Hawking's quote and the mind of God image appear in the other texts as well, creating an image of Cosmologists-as-Priests.

The texts present an image of cosmologists who enjoy access to and knowledge of God through the laws of physics. As a result, in these passages, cosmologists fulfill the role of priests, delivering this divine knowledge from God to society. As Smoot proclaims, cosmologists see the simplicity, symmetry, and order in the universe through the laws and principles of physics that "the ancient mythologies reserved for their gods" (WT: 297). In a sense, the cosmologists assume the role of writing Scripture, although Lederman is the only one who actually does. We will see below that the texts discuss experimental and

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[9] Moore discusses the "mind of God" concept in Hawking and Davies, arguing the authors associate God with mathematics and the laws of physics (Moore, 1995). This corresponds to Laws-*as*-God (see p. 12).

[10] Weinberg tries to refrain from God metaphors. He argues that the abstract uses of 'God' tends to render the concept unimportant (DFT: 245) (see pp. 56-59).

theoretical research. In these sections, cosmologists also assume priestly functions, obtaining access to God through research.

Spiritual Research

The texts often discuss experimental and theoretical research in terms of religious imagery that gives the research mystical and spiritual qualities. Concerning experimental physics, some of the authors describe instruments in terms of scientific-religious imagery. The images discussed in this section place cosmologists in the role of priests and present them as spiritual men and women.

Smoot's description of a South Pole expedition to measure galactic emissions (to be used in the COBE data analysis) gives it qualities of a spiritual journey. Smoot claims the journey possessed religious qualities. For example, Smoot states that arriving at Antarctica for the first time and viewing the landscape was "as close to a transcendental experience as one can have on Earth" (WT: 259). He also writes:

> Working at the South Pole has some transcendental qualities to it -- especially when you are outside and alone. Out where we were, two kilometers from the pole, it is very flat, bright, and isolated. You have to look hard to find the station in the distance. It can be like a surreal dream, you and your instrument alone in a vast whiteness. You have no outside distractions. You can focus completely on the moment. You must pay attention to what you are doing. The experience was like fasting on a religious retreat or being in a sensory deprivation tank, but with a keen edge. With several different experiments under way, each member of the team had this experience. Michele Limon, suffering from frostbite to the end of his nose, came stamping into the tent slapping his hands together to shake off the cold and warm up. Asked how he was, Michele replied, "I feel so alive here. I love it in spite of the misery." He was right; there was something pure and exhilarating about the experience.
>
> (WT: 270-271)

In addition to the references to "transcendental qualities" and "fasting on a religious retreat," Smoot's description of the experimenter and his or her instrument isolated in a "vast whiteness," seeking knowledge of the universe,

parallels a vision quest ("a surreal dream") or meditation experience (like "being in a sensory deprivation tank," "focus[ing] totally on the moment"). In addition, Smoot writes that the trip became a personal, life threatening test in which he collapsed and fell ill as a result of the harsh working conditions (WT: 255, 265). Smoot and the research team faced many hardships in a foreign and "alien" land. The expedition becomes a test of will and challenge to Smoot's conviction as a scientist. All these images liken the Antarctica expedition to a spiritual journey and compare the cosmologists to spiritual men and women. Seeking revelation (i.e., experimental data), they fast, meditate, and endure hardships in order to continue the cosmological quest to understand the universe and our existence.

Other texts also present experimental as well as theoretical research in terms of mystical and revelatory experiences. During the planning stages of the COBE project, the possibility of placing COBE in orbit around a Lagrangian point arose.[11] Smoot writes that the principle investigators "acted as if they had a religious experience" (WT: 221-222). Similarly, Lederman writes how an early morning discovery created a feeling of "mystical euphoria" (GP: 273). Moving to theoretical work, Davies lists examples of physicists' mystical and revelatory experiences involved with scientific practice.[12] In a section addressing mystical knowledge, Davies writes:

> Einstein spoke of a "cosmic religious feeling" that inspired his reflections on the order and harmony of nature. Some scientists, most notably the physicists Brian Josephson and David Bohm, believe that regular mystical insights achieved by quiet meditative practices can be a useful guide in the formulation of scientific theories.

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[11] Lagrangian points signify positions where the Sun's, Earth's, and Moon's gravity cancel each other out. The possible point for COBE, L2, experiences low levels of radiation and electromagnetic interference from the Earth and Moon, representing an ideal location for a cosmological satellite (WT: 221-222).

[12] Davies' examples of mysticism appear within a discussion about the limits of scientific knowledge. Davies critically examines the boundaries of scientific knowledge, and acknowledges that mysticism may provide a road to knowledge outside of scientific reason. Yet, as a scientist, Davies personally chooses science, and believes that history shows the success and merits of this approach.

> In other cases mystical experiences seem to be more direct and revelatory. Russell Stannard writes of the impression of facing an overpowering force of some kind, "of a nature to command respect and awe.... There is a sense of urgency about it; the power is volcanic, pent up, ready to be unleashed."
>
> ...
>
> For other scientists the revelatory experience happens spontaneously, in the midst of the daily clamor. Fred Hoyle relates such an incident that occurred to him while he was driving through the North of England. "Rather as the revelation occurred to Paul on the Road to Damascus, mine occurred on the road over Bowes Moor."
>
> (MG: 227-228)

In these descriptions, cosmologists gain mystical insights through meditation and experience religious feelings and revelations while conducting scientific research. Further, Hoyle compares his experience to that of Paul's. Thus, in addition to experiments, cosmologists experience revelations and mystical events in theoretical research. On top of this, Davies also discusses moments of mathematical inspirations (MG: 228, 142-145). Finally, Weinberg notes how some of his colleagues, in contemplating nature, experience spiritual satisfaction equivalent to religious belief in God (DFT: 256). These descriptions of cosmological research give cosmologists spiritual and mystical dimensions. The cosmologists become spiritual men and women, functioning as a scientific clergy.

Still other passages focus on scientific instrumentation. These machines and tools become religious objects and places, enabling the cosmologists to obtain knowledge of God and the universe. For example, Lederman includes a quote from Robert Wilson, an accelerator builder and architect, comparing accelerators to cathedrals. Consider the following excerpt from the Wilson passage:

> I even found, emphatically, a strange similarity between the cathedral and the accelerator: The one structure was intended to reach a soaring height in space; the other is intended to reach a comparable height in energy. Certainly the aesthetic appeal of both structures is primarily technical. In the cathedral we see it in the functionality of the ogival arch construction, the thrust and then the counterthrust so vividly and

> beautifully expressed, so dramatically used. There is a technological aesthetic in the accelerator, too. There is a spirality of the orbits. There is an electrical thrust and a magnetic counterthrust. Both work in an ever upward surge of focus and function until the ultimate expression is achieved, but this time in the energy of a shining beam of particles.
>
> (GP: 254)

Notice the similarity of the last sentence to the ideas expressed in Lederman's Very New Testament. Once constructed, the SSC -- the successful Tower of Babel -- reaches up to God and discovers the Higgs particle, achieving Wilson's "ultimate expression" (or, according to the Very New Testament, reaching the mind of God) (see (GP: 24) on pp. 74-75). After the Wilson quote, Lederman adds the following:

> To which I can only add that there is this deeper connection: both cathedrals and accelerators are built at great expense as a matter of faith. Both provide spiritual uplift, transcendence, and, prayerfully, revelation. Of course, not all cathedrals worked.
>
> One of the glorious moments in our business is the scene in a crowded control room, where the bosses, on this special day, are at the console, staring at the screens. Everything is in place. The labor of so many scientists and engineers for so many years is now about to hatch as the beam is traced from the hydrogen bottle through the intricate viscera...It works! Beam! In less time than you can say hooray, the champagne is poured into Styrofoam cups, jubilation and ecstasy written on all faces. In our holy metaphor I see the workmen lowering the last gargoyle into place as priests, bishops, cardinals, and the requisite hunchback stand tensely around the altar to see if it works.
>
> (GP: 254-255)

So, Lederman expands on Wilson's metaphor. The accelerator functions like a place of worship where cosmologists, acting as priests, conduct research. The experiments, according to Lederman, provide spiritual uplift, transcendence, and revelation. With the link to the Very New Testament, Lederman presents the accelerators, under the control of physicists, as a path to God. While Wilson's metaphor implicitly places cosmologists in the role of priests, Lederman expands on the metaphor and directly compares cosmologists to priests. In another

passage, Lederman offers us two choices if we want to learn about the Higgs particle:

> And how do we learn more about [the Higgs particle]? Since it is Her [i.e., God's] particle, we can wait, and if we lead an exemplary life, we'll find out when we ascend to Her kingdom. Or we can spend $8 billion and build us a Super Collider in Waxahachie, Texas, which has been designed to produce the Higgs particle.
>
> (GP: 372)

This adheres to Laws-*of*-God: cosmologists learn about God through God's creation. Cosmologists, through instruments like the SSC, obtain heavenly, or divine, knowledge. Further, this passage shows how Lederman links his arguments for the SSC to the scientific-religious imagery presented in the texts (discussed below on pp. 73-76). Lederman's accelerator imagery, then, ties into the idea that cosmologists discover Laws-*of/as*-God and will one day know the mind of God, reinforcing the image of cosmologists acting as a scientific clergy.

In a different story, or myth, Lederman presents the search for the Higgs particle in terms of a mythical confrontation between good and evil. Lederman writes:

> We're building a tunnel fifty-four miles in circumference that will contain the twin beam tubes of the Superconducting Super Collider, in which we hope to trap our villain.
>
> And what a villain! The biggest of all time! There is, we believe, a wraithlike presence throughout the universe that is keeping us from understanding the true nature of matter. It's as if something, or someone, wants to prevent us from attaining the ultimate knowledge.
>
> This invisible barrier that keeps us from knowing the truth is called the Higgs field. Its icy tentacles reach into every corner of the universe, and its scientific and philosophical implications raise large goose bumps on the skin of a physicist. The Higgs field works its black magic through -- what else? -- a particle. This particle goes by the name of the Higgs boson.
>
> (GP: 22)

In another passage, Lederman refers to the Higgs field as a "dark force" (GP: 2). Lederman presents cosmologists as fighting the evil Higgs particle with the SSC

to obtain "ultimate knowledge." The SSC, then, will allow cosmologists to overcome the biggest villain of all time. In addition, this myth places cosmologists in the role of spiritual leaders on the quest for "ultimate knowledge."

Smoot and Lederman also use time machine metaphors to present cosmologists, through instrumentation, gaining knowledge of and access to God. Lederman discusses accelerators as time machines, reaching back to the moments of the early universe as the accelerators reach higher energies (GP: 26). Lederman ties this to the God particle, stating that the early universe contains important clues about the Higgs (GP: 253-254). Thus, as the accelerator reaches up to heaven like the Tower of Babel, it also reaches back in time to the big bang -- God's "One Great Experiment" (GP: 24, 388). Both lead to the mind of God via the Higgs particle. Smoot uses this image as well for COBE. COBE observes the cosmic microwave background radiation left over from the early universe, taking "baby pictures of the newborn cosmos" (WT: 237, 196). In this sense, COBE looks back in time. As with the accelerators, COBE leads to God, allowing Smoot to see God.[13] The time machine and cathedral metaphors make accelerators and satellites cosmology's religious objects which facilitate access to God. The instruments function like objects of worship with research representing the act of worship. In addition, big instruments serve as gathering places where cosmologists experience God. The presentation of instrumentation as religious objects and gathering places, then, gives cosmologists the role of priests, reinforcing the image in texts.

In these passages, research becomes a spiritual journey, meditation, or an act of worship. Through experiments and theoretical contemplation, cosmologists endure hardships, experience religious feelings, and gain spiritual satisfaction. The texts present research as a religious experience or practice. In addition, through research, the cosmologists obtain mystical insights and revelations. Thus, the texts present cosmologists as spiritual people who function like priests, studying God and the spiritual. The imagery concerning satellites and accelerators presents instrumentation as religious objects and

[13] See footnote 8.

places. These instruments aid cosmologists, functioning as priests, in their attempt to understand God's laws or even the mind of God. Further, in the case of accelerators and satellites, the instruments also serve as places of worship where the scientific clergy can gather and conduct research.[14] Thus, accelerators, detectors, and experimental procedures assume the functions of churches, altars, and ritualistic acts. This imagery presents cosmologists as spiritual men and women and places them in priestly roles. The cosmologists, through research, acquire knowledge of God which then gets imparted to society. Cosmologists become clergy, a group of priests that enjoy a privileged access to the mind of God; they are spiritual leaders.

Martyrs and Gods

Going one step further, the texts also create images of cosmologists as martyrs and gods which reinforce the mystical and spiritual qualities the texts give cosmologists through Cosmologists-as-Priests. While discussing the hardships of experimental physics, Lederman presents the martyr image in the following passage:

> When I talk about the pain and hardship of a scientist's life, I'm speaking of more than existential angst. Galileo's work was condemned by the Church; Madame Curie paid with her life, a victim of leukemia wrought by radiation poisoning. Too many of us develop cataracts. None of us gets enough sleep. Most of what we know about the universe we know thanks to a lot of guys (and ladies) who stayed up late at night.
>
> (GP: 16)

Ranging from late nights to death, the physicists suffer. Lederman also refers to Galileo's condemnations and house arrest in other passages, including a section entitled "Pope to Galileo: Drop Dead" (GP: 65, 83-84). Hawking also brings up Galileo. Regarding a Vatican conference on cosmology, Hawking writes:

> The Catholic Church had made a bad mistake with Galileo when it tried to lay down the law on a question of science, declaring that the sun went

[14] Even though researches do not gather at the orbiting satellite, they congregate at earthly locations (e.g., control rooms, offices, the internet).

> round the earth. Now, centuries later, it had decided to invite a number of experts to advise it on cosmology. At the end of the conference the participants were granted an audience with the pope. He told us that it was all right to study the evolution of the universe after the big bang, but we should not inquire into the big bang itself because that was the moment of Creation and therefore the work of God. I was glad then that he did not know the subject of the talk I had just given at the conference -- the possibility that space-time was finite but had no boundary, which means that it had no beginning, no moment of Creation. I had no desire to share the fate of Galileo, with whom I feel a strong sense of identity, partly because of the coincidence of having been born exactly 300 years after his death!
>
> (BHT: 116)

Hawking compares himself to Galileo, fearing reprisal for his scientific theories. Smoot mentions Galileo's condemnation as well as Giordano Bruno, who was burned at the stake (WT: 22, 24). Further, Smoot's account of the South Pole expedition discusses the suffering and life-threatening hardships endured by the research team.

At first glance, the references to scientific figures persecuted by religion appears to place cosmology as standing in opposition to religion, suggesting an incompatibility between them. However, the martyr imagery actually helps create the model of Cosmology-as-Religion. Specifically, the imagery gives cosmology martyrs like those of religion, and it suggests a similarity between cosmology and religion. If we remember that religious martyrs sometimes meet their fate at the hands of other religions, then we can see that the martyr imagery supports the Cosmology-as-Religion model.

These passages create the image of cosmologists as martyrs in several ways. First, the authors refer to historical figures, like Galileo and Madame Curie. Second, the texts discuss the suffering and dangers of science. Research involves the threat of sickness and even, in the South Pole experiments, death. In addition, the authors discuss the dangers, at least historically, of holding to scientific convictions -- highlighted by Hawking's discussion of the Vatican conference. The point is that cosmologists become martyrs because they suffer. They endure hardships to perform science, citing

their predecessors who have paid for these convictions with imprisonment and death. The scientific martyrs function like their religious counterparts who likewise suffer in order to hold on to religious convictions.

Finally, the texts create an image of Cosmologists-as-Gods. Consider the following passage from *The Mind of God*:

> Part of the job of the mathematical physicist is to examine certain idealized mathematical models that are intended to capture only various narrow aspects of reality, and then often only symbolically. The models play the role of "toy universes" that can be explored in their own right, sometimes for recreation, usually to cast light on the real world by establishing certain common themes among different models. These toy universes often bear the name of their originators. Thus there is the Thirring model, the Sugawara model, the Taub-NUT universe, and so on. (MG: 33)

The physicists assume God-like functions. First, they create universes. Second, the cosmologists play with their creations. In other words, they manipulate and control the universes, asserting their power and dominance over these "toy universes." Smoot claims particle accelerators create "little bangs," mimicking the early universe and the big bang moment of creation (WT: 94, 97, 109), and Lederman's time machine-accelerator metaphor and Very New Testament (see pp. 32-34, 35) describe the SSC as "reach[ing] back to the beginning of time" (GP: 24). Here, physicists recreate the beginning of the universe and, again, function as creators. So, the authors present cosmologists as gods. They create, manipulate, and control universes; they even recreate the beginning of our universe.

Cosmologists-as-Martyrs presents cosmologists as spiritual leaders, suffering in their pursuit of cosmological revelation, and Cosmologists-as-Gods gives them access to the secrets of the universe. Both images reinforce Cosmologists-as-Priests; they add further spiritual and mystical dimensions to the cosmologists. As with the other imagery discussed above, cosmologists become a scientific clergy -- a group who enjoys a privileged access to divine knowledge and power.

Summary

Laws-*of*-God places cosmologists in the role of interpreters of God's message, like interpreters of Scripture. Further, cosmologists enjoy direct access to God through Laws-*as*-God. Here, they write Scripture and deliver God's Word. According to Laws-*on*-God, the cosmologists have direct access to an authority over God. In all three, cosmologists function as priests. We have seen that the texts develop these images further. Basically, Cosmologists-as-Priests operates on two levels. First, as a scientific clergy, cosmologists belong to a special group that has access to God and divine knowledge. Second, cosmology becomes a religious or spiritual endeavor. Both themes make cosmologists spiritual leaders or priests.

The texts present cosmologists as a privileged group of people who enjoy access to God and divine knowledge. As we have seen, the image that cosmologists can know the mind of God reinforces Laws-*as*-God -- that cosmologists learn about God who is the laws of physics. Instruments function as religious objects which facilitate the quest to know God. Further, big machines, like accelerators and satellites, serve as gathering places for cosmologists. So, around these machines, the faithful come together to worship and study God. As a result, in these passages, cosmologists fulfill the role of priests. The cosmologists, through the laws of physics and research with instruments and machines, acquire knowledge of God which they impart to society. Cosmologists become clergy, a body of priests that enjoy a privileged access to divine knowledge and God. They function as spiritual leaders.

In other passages, cosmology represents a mystical calling and research becomes a spiritual journey, meditation, or act of worship. During research, cosmologists gain spiritual satisfaction, mystical insights, and revelation. Further, the cosmologists endure hardships and suffering in their practice. Looking again at instrumentation, research serves as ritualistic practices or acts of worship centered on the instruments and machines which function as religious objects. Research becomes a spiritual and religious quest. Thus, the texts present cosmologists as spiritual people who function like priests, studying God and the mystical. In addition, Cosmologists-as-Martyrs/Gods reinforce the image of cosmology as a religious practice. The martyr image highlights the suffering

aspect of research and the image of cosmologists as religious leaders while Cosmologists-as-Gods adds to the spiritual and mystical powers the texts grant cosmologists. Taken together, this imagery presents cosmologists as spiritual men and women who undergo suffering and hardships in order to gain mystical insights and revelation. As a result, the texts create an image of Cosmologists-as-Priests.

Meaning and Purpose

Several of the authors present cosmology as offering meaning and purpose to our existence which gives cosmology another religious function. The texts offer meaning and purpose in two ways. First, some authors define a place for humans in the universe, claiming that cosmology demonstrates that humans fulfill a role in the universe. As a result, cosmology reveals that life has purpose and meaning.[15] Second, Smoot presents cosmology as a myth and compares it to religious creation myths. As a result, cosmology provides meaning and purpose to our lives through myth.

Cosmology offers meaning and purpose by showing that humans fit into the design or organization of the universe. According to Davies, cosmology provides a sense of purpose to our lives. Consider the following passage:

> I belong to a group of scientists who do not subscribe to a conventional religion but nevertheless deny that the universe is a purposeless accident. Through my scientific work I have come to believe more and more strongly that the physical universe is put together with an ingenuity so astonishing that I cannot accept it merely as a brute fact. There must, it seems to me, be a deeper level of explanation. Whether one wishes to call that deeper level "God" is a matter of taste and definition. Further, I have come to the point of view that mind -- i.e., conscious awareness of the world -- is not a meaningless and incidental quirk of nature, but an absolutely fundamental facet of reality. That is not to say that *we* are the purpose for which the universe exists. Far from it. I do, however, believe

[15] This sense of purpose does not represent an anthropic argument which, in its strong sense, tends to suggest that humans fulfill *the* purpose of the universe or that humans actually are *the* purpose of the universe.

> that we human beings are built into the scheme of things in a very basic way.
>
> (MG: 16)

Here, Davies discusses a God-like "deeper level of explanation" that lies behind the universe's organization. Further, the universes does not result from a "purposeless accident," implying a sense of purpose and meaning to the universe. Finally, Davies argues that conscious awareness represents a meaningful part of the universe. Humans and other conscious beings fit into a the grand "scheme of things." Davies later explains that conscious beings give the universe a self-awareness, concluding that: "This can be no trivial detail, no minor byproduct of mindless, purposeless forces. We are truly meant to be here" (MG: 232). Thus, our existence has meaning; we have a purpose. Following up on these images, Davies writes:

> Far from exposing human beings as incidental products of blind physical forces, science suggests that the existence of conscious organisms is a *fundamental* feature of the universe. We have been written into the laws of nature in a deep and, I believe, meaningful way. Nor do I regard science as an alienating activity. Far from it. Science is a noble and enriching quest that helps us to make sense of the world in an objective and methodical manner. It does not deny a meaning behind existence. On the contrary. As I have stressed, the fact that science works, and works so well, points to something profoundly significant about the organization of the cosmos. Any attempt to understand the nature of reality and the place of human beings in the universe must proceed from a sound scientific base. Science is not, of course, the only scheme of thought to command our attention. Religion flourishes even in our so-called scientific age. But as Einstein once remarked, religion without science is lame.
>
> (MG: 21)

Again, according to Davies, cosmology makes sense of our world and implies a meaning to our existence -- we are a "fundamental feature of the universe." Beyond this, Davies asserts the need for science in order to understand our place in the universe, citing Einstein's statement that religion without science is lame. According to Davies, not only can cosmology provide meaning and

purpose to our existence, but such an understanding *requires* cosmology. In addition, this passage provides an example of how Davies links his scientific-religious imagery to arguments justifying cosmology (see pp. 79-80). Thus, cosmology provides meaning and purpose to our lives; it uncovers a God-like deeper level of explanation and demonstrates the fundamental part conscious beings play in the universe.

Other authors also discuss meaning and purpose to our existence. In his "mind of God" quotation (see (BHT: 175) on p. 28), Hawking claims that cosmology may soon have a theory of everything which will allow us to addresses "why it is we and the universe exist" (BHT: 175). In the concluding sections of his text (see (WT: 296-297) on pp. 77-78), Smoot discusses the meaning of our existence. In the first paragraph quoted, Smoot states that cosmologists find an underlying unity in nature, which suggests a meaning behind our universe. In addition, Smoot states "there is an overall inevitability to the development of complex systems" and "the development of beings capable of questioning and understanding the universe seems quite natural." Like Davies, Smoot believes our existence fits into the organization of the universe, and he suggests that there is an underlying meaning and purpose to the existence of the universe and intelligent life. As Smoot writes, "the universe seems quite the opposite of pointless." Finally, Barrow suggests a unique purpose to human life when he states:

> Our tortuous journey through the labyrinth of wormholes to the beginnings of time has brought us back four-square to the fact of our own existence as an important datum in our search for the origins of the universe and its remarkable panoply of properties.
>
> (OU: 127)

In other words, our existence provides vital information to our understanding of the universe. In that sense, our lives have a purpose. All three of these authors suggest, to greater and lesser extents, that cosmology provides a sense of meaning and purpose to our lives.

Weinberg discusses the possibility that the final theory may reveal a special place for intelligent life in the universe:

> Not all scientists would agree with my bleak view of the final laws. I do not know of anyone who maintains explicitly that there is scientific evidence for a divine being, but several scientists do argue for a special status in nature for intelligent life.... If...we found some special role for intelligent life in the final laws at the point of convergence of the arrows of explanation, we might well conclude that the creator who established these laws was in some way specially interested in us.
>
> (DFT: 251)

Weinberg does not feel the final laws will reveal a special status for intelligent life (see pp. 56-59). However, the idea expressed in this passage parallels the other texts: the existence of human beings fits into the grand scheme of the universe in a meaningful way.

The texts also offer meaning and purpose to our lives through myth. Smoot specifically compares big bang theory to religious creation myths. Smoot claims that cosmological theories of creation serve the same functions that religious creation myths fulfill. Consider the following passage:

> Others feel [big bang theory has mystical qualities], too, as evidenced by the frequent appearance of newspaper stories about the [big bang] theory -- that some new piece of evidence supports it or threatens it, or that the absence of evidence leaves it unsupported. So much attention to a scientific theory by society at large speaks to the mythical force of the theory. People know it is science, but want it to be more. For instance, at the 1993 annual meeting of the American Association for the Advancement of Science, held in Boston, in a session called "The Theological Significance of Big Bang Cosmology," scientists and theologians sought connections between the fundamental science of the big bang, as described by current theory, and the Christian story of creation. There is no doubt that a parallel exists between the big bang as an event and the Christian notion of creation from nothing.... It is of no small significance that in 1951 Pope Pius XII invoked big bang theory and observational evidence that supports it: "Scientists are beginning to find the fingers of God in the creation of the universe."
>
> Man has always been obsessed by the search for his own origins. Creation myths are ubiquitous, and in the ancient world images of the cosmos were often central to all aspects of life -- religious, political, and

> military. It is therefore not surprising that the big bang, even in this modern secular world, often takes on the dimensions of myth.
>
> As science, the big bang is a powerful theory for explaining the origin and the evolution of the universe. But our desire to understand the universe reaches far deeper than the history of science and its rational methods. As Joseph Campbell, the world's foremost interpreter of mythology has said: "What we humans are looking for in a creation story is a way of experiencing the world that will open to us the transcendent, that informs us and at the same time forms ourselves within it. That is what people want. This is what the soul asks for." Society hungers for both science and mythology, and the big bang theory is where the two mingle most intimately.
>
> (WT: 17-18)

Smoot discusses the "mythical force" of big bang theory, evidenced by social interest in the theory. Smoot also compares the big bang to religious creation myths in general. Specifically, Smoot discusses the theory's relationship to Genesis, citing the AAAS conference and Pope Pius XII's invocation.[16] Finally, Smoot quotes Joseph Campbell. Here, Smoot offers big bang theory as providing the spiritual satisfaction society looks for in creation myths, allowing us to experience the transcendent and define our place in the world. Big bang theory fulfills society's "hunger" for science and mythology. The last paragraph in *Wrinkles in Time* reinforces the image of cosmology as myth (see (WT: 296-297) on pp. 77-78). According to Smoot, the cosmological version of creation contains the same sense of awe and wonder as religious creation myths (WT: 297). So, Smoot creates an image of big bang theory as a creation myth. This gives cosmology another religious function -- myth production.

The texts present cosmology as a myth and compare it to religious myths. As a result, the texts create an image of cosmology that provides meaning and purpose to our lives through myth. In addition, the texts define a place for humans in the universe. Cosmology, then, reveals that our existence serves a purpose. Thus, cosmology answers, or offers the possibility of answering, one of

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[16] Davies and Hawking also mention Pope Pius XII's acceptance of big bang theory as in accord with the Catholic Church's teachings (MG: 47) (BHT: 46-47).

the ultimate questions: why are we here? It defines a purpose to our existence and offers meaning to our lives, functions often performed by religion.

Cosmology and Theology: Positioning Tactics

The texts compare cosmology and religion through the positioning of scientific and theological ideas. A common pattern proceeds as follows: 1) introduce idea with theological formulation, 2) follow with intermediate history of science, and 3) conclude with contemporary scientific version of the original religious idea. In other cases, the texts simply compare cosmological theories to theological concepts. This positioning asserts cosmology's ability to address theological issues and perform this religious function.

Following the pattern, Hawking discusses some religious cosmologies, then talks about Hubble and the development of big bang theory, and ends with the contemporary version of big bang theory (BHT: 7-8). Discussing the concept of time, Davies and Smoot introduce St. Augustine's view that God created time as part of the physical universe (i.e., God exists outside of time). Then, skipping the middle step in the pattern, they discuss this concept in contemporary big bang theory (i.e., that time and space came into existence at the moment of the big bang) (MG: 50) (WT: 166). In more detail, Davies looks at religious myths concerning time and creation, concluding with some scientific positions (MG: 40-44). Smoot uses this form while discussing a universal frame of reference. First, Newton postulated absolute space, which he associated with God, as the frame of reference. Next, the universal aether replaced Newton's absolute space. Now, according to Smoot, the cosmic microwave background radiation provides a frame of reference (WT: 116-117).[17] Smoot's example differs somewhat from the others, but it shares a common theme: a scientific concept replaces God or a religious idea. Positioning scientific theories in this way, the authors accomplish two things. First, they compare cosmology to religion, which asserts cosmology's ability to handle theological issues. Second, the authors present a

[17] Smoot participated in experiments which used the background radiation to determine that the universe does not rotate.

historical progression in which cosmology replaces religion by addressing theological issues.[18]

Another method of positioning simply compares cosmological theories with religious doctrines (not necessarily following the order of religion, then science). In these cases, the texts present cosmology as dealing with theological issues, but do not use the historical progression discussed above. For example, Smoot discusses big bang theory's relationship to the Christian concept of creation *ex nihilo* (i.e., creation from nothing) (WT: 17, 292), while Davies compares quantum cosmology to creation *ex nihilo* (MG: 44-45). Weinberg mentions St. Augustine in a discussion about time and the beginning of the universe (DFT: 174). In addition, Barrow compares certain versions of big bang theory to the "ancient" ideas of a cyclic universe (OU: 29, 45). Finally, regarding creation stories, Barrow writes:

> The various creation stories of ancient times were not scientific theories in any modern sense. They did not attempt to reveal anything new about the structure of the world; they aimed simply to remove the specter of the unknown from human imaginings. By defining their place within the hierarchy of creation, the ancients could relate the world to themselves and avoid the terrible consideration of the unknown or the unknowable. Modern scientific accounts need to achieve much more than this. They must be deep enough to tell us more about the universe than we have put into them. And they must be broad enough to make predictions, as a

[18] Stephen G. Brush discusses several criticisms of science-history (i.e., history of science written by scientists) leveled by historians of science. Brush argues that scientists have a lot to contribute to the history of science, especially their technical/scientific expertise, but he believes that science-historians should learn historiographic techniques (Brush also feels historians of science should learn some science) (Brush, 1995, 215). Brush discusses Paul Forman's criticism that science-historians produces whig histories. A whig history distorts the past based on presentist views (Brush, 1995, 217, 225-226). According to Forman, science-historians' whig interpretations produce a celebration, versus critical examination, of modern science (Forman, 1991, 81-82). The historical progression presented by the primary texts represents a whig perspective which projects contemporary scientific theories back into the past. The authors present current theories as the result of a historical progression from religious conceptions of those theories to the contemporary scientific versions. This creates the impression that cosmological theories are the inevitable result of this historical process and affirms contemporary cosmology. As a result, the image of cosmology superseding religion seems like the natural and inevitable course of events.

> check on their credentials to explain the things we already know about the world. They bring a coherence and unity to collections of disconnected facts.
>
> (OU: xii)

Although Barrow does not specifically mention religion or theology, he compares scientific to ancient (i.e., non-scientific) creation accounts. Notice Barrow does not state that scientific creation theories perform different functions than ancient stories. Instead, he writes that scientific theories do more. Thus, Barrow presents cosmological theories as superseding the ancient ones. In addition, with cosmology superseding the ancient accounts, this passage implies that cosmology allows us to define our place in the world like the ancient stories. This ties into the idea the cosmology can provide meaning and purpose to our lives (discussed above). Even these simple comparisons present a cosmology that handles theological issues and, in various degrees, supersedes religion.

The texts accomplish two things through these positioning tactics. First, comparing scientific ideas with religious concepts asserts cosmology's ability to addresses theological issues. Second, by presenting the progression of concepts from their religious formulation to the scientific version, the texts present cosmology as superseding religion. To some extent, the comparisons without the historical progression do this as well. In both cases, cosmology addresses and sometimes takes over various theological issues (especially concerning the creation of the universe). In other words, positioning gives cosmology another religious function -- the study of theological issues.

Sum of the Parts: Cosmology as Religion

The use of theological concepts and religious language, metaphors, and images creates scientific-religious imagery in which cosmology and cosmologists perform religious functions. As a result, the texts present a model of cosmology as religion in the sense that cosmology and cosmologists assume these roles. Taken as a whole, Cosmology-as-Religion contains many of the elements common to conventional Western religion.

As we have seen, the imagery concerning the laws of physics and cosmologists works on several levels. Laws-*as*-God replace God in the creation

and governance of life and the universe. As a result, cosmologists enjoy direct access to God via the laws. They perform as priests, writing Scripture (i.e., the formal representations of laws) and delivering God's Word to society; they speak for God. With Laws-*on*-God, cosmologists have a similar relationship, but with an agency above God. At a different level, cosmologists learn about God's design and creation represented in the Laws-*of*-God. Here, cosmologists function as priests interpreting Scripture. In addition, cosmologists, acting as priests, use instruments and machines in their quest to know God. The scientific instrumentation serves two roles. First, instruments perform as objects of worship which enable cosmologists to experience God and acquire divine knowledge. Second, large machines, like accelerators and satellites, serve as gathering places for cosmologists.[19] Around these machines, then, a scientific clergy comes together to worship (i.e., study) God. Finally, research functions as a spiritual process or act of worship. The cosmologists subject themselves to suffering (Cosmologists-as-Martyrs) in order to obtain mystical insights and revelation. In addition, research becomes a ritualistic act of worship centered around scientific instrumentation. Thus, through the laws of physics, research, and instrumentation, cosmologists experience the mind of God. They acquire divine knowledge and impart it to society. The cosmologists function as a scientific clergy -- a privileged group of holy men and women, or spiritual leaders, who have access to God and divine knowledge.

Beyond this, cosmology provides meaning and purpose to our existence by defining a role for humans, or any intelligent life, in the universe and providing society with modern creation myths like big bang theory. In addition, the positioning of scientific and theological ideas presents cosmology as addressing theological issues. Therefore, cosmology assumes these religious functions as well. Finally, through Laws-*on/as*-God and positioning tactics, the texts create an image of cosmology superseding religion, reinforcing cosmology's assumption of these religious duties.

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[19] In her ethnographic study of HEP, Sharon Traweek discusses the role of instrumentation (e.g., accelerators and detectors) in shaping and identifying the HEP community (Traweek, 1988).

All these dimensions converge on a single theme: the model of Cosmology-as-Religion. Interestingly, Cosmology-as-Religion places the authors in the role of priests, delivering divine knowledge to the lay public with the primary texts. In any case, Cosmology-as-Religion contains many elements of conventional religion, including Scripture, priests, and creation myths. The model even contains an infrastructure: instrumentation serves as objects of worship; large machines function as gathering places or churches; and research performs as a set of ritualistic practices. Therefore, Cosmology-as-Religion includes institutional structures as well. We can see that Cosmology-as-Religion contains many important aspects of religion -- both conceptually and physically.

The next chapter addresses the non-religious imagery that appears in the texts and discusses how that imagery relates to Cosmology-as-Religion. After this, Chapter 4 explores Cosmology-as-Religion's appropriation of religious authority and the impact it has on the justificatory arguments that also appear in the texts.

CHAPTER 3: Non-Religious Imagery

In addition to the religious imagery discussed above, the texts contain non-religious imagery (e.g., detective story and music metaphors) that does not, at least at first glance, fit into Cosmology-as-Religion. However, some of the non-religious imagery actually complements and becomes part of Cosmology-as-Religion. Further, we can see a qualitative difference between the scientific-religious and non-religious imagery. The non-religious imagery consists of various themes scattered throughout the texts while the scientific-religious imagery forms a coherent model and appropriates religious functions. As a result, this chapter argues that the non-religious imagery does not interfere with my arguments concerning the role of scientific-religious imagery in creating the model of Cosmology-as-Religion (detailed in Chapter 2) or that model's appropriation of authority and legitimation of cosmology (discussed below in Chapter 4).

Despite its diverse character, the texts share some common themes in their use of non-religious imagery. First, some of the authors use a detective story metaphor in which cosmology uncovers the mysteries of the universe. The texts also develop aesthetic imagery. Here, the authors discuss how concepts like beauty, simplicity, and symmetry relate to cosmology. This chapter closes with a discussion of Weinberg's views against the use of religious imagery, especially images of or involving God, and his conviction that science cannot perform some of the religious functions discussed above. I will argue that, despite Weinberg's arguments, his text functions like the others, creating scientific-religious imagery.

Detective Story: The Mysteries of the Universe

Barrow and Lederman use a detective story metaphor in their texts. Here, cosmology attempts to solve the mysteries of the universe. As a result, these authors develop an image of cosmology different from that of Cosmology-as-Religion. Yet, even so, the detective story does not dominate the texts or replace the scientific-religious imagery.

Barrow begins his chapters with epigraphs from Sherlock Holmes mysteries. In addition, many of the unanswered questions of cosmology are dubbed "great

mysteries" (e.g., the smoothness of the cosmic microwave background, the singularity at the beginning of the universe, and the concept of time in quantum mechanics) (OU: 17, 38, 96). However, Barrow does not develop this image further in the text. It remains, for the most part, confined to the epigraphs and occasional "mystery" references. As a result, the detective story image does not interfere with the scientific-religious imagery. I must point out, however, that Barrow does not present a well-developed Cosmology-as-Religion model either. Barrow focuses on explaining the physical (versus philosophical or theological) concepts of cosmology, and he generally refrains from creating any strong scientific-religious imagery. However, when we see scientific-religious imagery, it is in the expected places: the creation of the universe and question of our existence. As discussed above, Barrow compares cosmological theories to religious, or "ancient," creation myths (OU: xii, 24-25, 45, 109), discusses theological impacts of cosmology (OU: 25, 37, 109), addresses the meaning of our existence in relation to the universe (100, 127, 137), and describes laws that transcend the universe (i.e., Laws-*as*-God) (OU: 27, 110, 113). In other words, the scientific-religious imagery appears in passages where, on the basis of the other texts, we would expect cosmology to assume religious functions. Since the detective story image does not appear in these passages, it does not interfere with or replace the scientific-religious imagery.

Lederman also uses the metaphor of a detective story, but, for the most part, it is confined to two small sections in the text. First, Lederman uses this metaphor to discuss two themes of his text: the search for the indivisible constituents of matter and the Higgs particle (GP: 20-22). However, the following pages present the Higgs as the God particle and contain the first passage of the Very New Testament (GP: 22, 23-24). Lederman also uses the detective story metaphor while discussing the history of quantum mechanics. The detective story consists of three "smoking guns" that developed in classical atomic theory: the ultraviolet catastrophe, the photoelectric effect, and the discovery of the nucleus (GP: 146-156). Each of these events contributed to the quantum revolution, the solution to Lederman's atomic mystery. Like Barrow,

Lederman also talks about "mysteries" of cosmology.[1] However, Lederman does not develop the detective story metaphor outside of these two isolated sections.

Lederman is a humorous and colorful writer, and his text includes many different images other than the detective mystery: physics as music (GP: 127); physicists as an orchestra (GP: 330); the SSC and God particle as Captain Ahab's harpoon and Moby Dick respectively (Lederman suggests that budgetary constraints prevented Ahab from getting a bigger harpoon that would have enabled him to kill Moby Dick. He then hopes the same thing doesn't happen to HEP because the "Moby Particle is within striking distance") (GP: 366); and many others including Santa Claus, Atlantis, and the land of Oz (GP: 183, 282, 393). The non-religious imagery occurs in comparable numbers to scientific-religious images in a few chapters discussing the history of science and the standard model. Yet, these chapters contain relatively low amounts of scientific-religious imagery compared to the rest of the text. In addition, taken together, these images, including the detective story, are scattered and inconsistent in the text. The scientific-religious imagery, on the other hand, forms a dominant, consistent theme: cosmology provides knowledge of God. As with Barrow's imagery, we find the scientific-religious imagery prominent when Lederman discusses the ultimate questions and the God particle (see Appendix B). So, again, while other imagery is present, the scientific-religious imagery stands out in comparison, especially around the ultimate questions.

Aesthetics: Simplicity, Beauty, and Symmetry

Simplicity, beauty, symmetry, and other aesthetic qualities represent themes in all of the texts except for *A Brief History of Time*. The authors talk about the aesthetic qualities in nature, the laws of physics, and mathematics. In addition, they present cosmology as searching for beauty, simplicity, and symmetry in nature, which cosmology uncovers through the laws of physics. Finally, according to some of the authors, these qualities help guide cosmology towards

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[1] Other authors also refer to cosmology's attempt to uncover the "mysteries" of the universe, but do not explicitly use a detective story metaphor (WT: 189) (DFT: 71, 205).

truth and an understanding of the universe.[2] For the most part, the scientific-religious imagery incorporates this sense of aesthetics. However, Weinberg represents a special case because he develops the imagery of aesthetics more than the other authors. In fact, Weinberg's concept of beauty replaces explanatory power as the goal of scientific theories.

The scientific-religious imagery of Lederman, Davies, Smoot, and Barrow incorporates the aesthetic themes. In Lederman's Very New Testament, God reveals the beauty of the universe to us through the God particle (see Appendix A). As discussed above, Davies offers the qualities of ingenuity, economy, and beauty as a possible conception of God (see (MG: 214-215) on pp. 22-23). Smoot writes:

> A powerful conviction for me, and one that I believe encourages confidence that one day we will understand the very essence of creation, is the idea that as we converge on the moment of creation, the constituents and laws of the universe become ever simpler.
>
> ...
>
> This increasing simplicity and symmetry of the universe as we near the point of creation gives me hope that we can understand the universe using the powers of reason and philosophy. The universe would then be comprehensible, as Einstein had yearned.
>
> (WT: 290-291)

Here, aesthetic qualities become part of the cosmological quest. In fact, according to Smoot, they constitute hope that cosmology will comprehend the universe and complete the quest. Smoot further discusses simplicity and symmetry in relation to the quest in the concluding passages of his text (see (WT: 296-297) on pp. 77-78). Finally, Barrow's discussion of aesthetics also incorporates scientific-religious imagery. He suggests the initial state of the universe might have been "governed by some grand principle of symmetry or

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[2] For example, Weinberg and Lederman discuss aesthetics in nature (DFT: 158, 250) (GP: 309, 383), and most of the authors attribute aesthetic qualities to laws and mathematics (DFT: 243) (GP: 265, 292) (MG: 143, 197-198) (WT: 188). In addition, Weinberg and Smoot present cosmology as searching for and revealing aesthetic qualities of nature (GP: 71, 345, 364) (WT: 14-15). Finally, Weinberg, Davies, and Barrow discuss aesthetics as a theoretical guide (DFT: 98, 104, 130) (MG: 175-176) (OU: 102, 106, 109).

economy," linking aesthetics to Laws-*as*-God (OU: 27). Further, Barrow claims that simplicity and economy play a role in quantum cosmology, which Barrow presents with scientific-religious imagery. Here, aesthetics guide theory development regarding the origin of the universe (OU: 102, 106, 109). So, the discussion of aesthetics coincides with and, as a result, becomes part of Barrow's use of scientific-religious imagery. In these texts, the concept of aesthetic qualities in nature and the laws of physics tie into the scientific-religious imagery, complementing, rather than weakening, the model of Cosmology-as-Religion. The aesthetic imagery facilitates the scientific-religious imagery's appropriation of religious functions.

Turning to *Dreams of a Final Theory*, Weinberg discusses beauty, simplicity, and symmetry more than the other authors. Aesthetics, especially the beauty of theories, plays a major role in his presentation of the quest for a final theory. Consider the following passage:

> Time and again physicists have been guided by their sense of beauty not only in developing new theories but even in judging the validity of physical theories once they are developed. It seems that we are learning how to anticipate the beauty of nature at its most fundamental level. Nothing could be more encouraging that we are actually moving toward the discovery of nature's final laws.
>
> (DFT: 90)

Thus, Weinberg asserts that beauty not only guides theory development and evaluation, but also shows progress in cosmology towards the final theory. In fact, Weinberg spends an entire chapter presenting three cases where he believes aesthetics guided theory development and evaluation (DFT: 90-131). In other passages, Weinberg goes even further. Like Smoot, Weinberg talks about a converging of theories as they get simpler (i.e., more beautiful), and as a result, he believes a final theory exists (DFT: 231-232). Finally, Weinberg states "the beauty of our present theories may be 'but a dream' of the kind of beauty that awaits us in the final theory" (DFT: 17). Weinberg's description of the search for a final theory involves beauty at all levels -- from theory development to becoming part of the final theory itself.

In addition to this, Weinberg spends another chapter discussing beautiful theories (DFT: 132-165). Here, we see the link between beauty and the

scientific-religious imagery in the text. Weinberg argues that simplicity, a sense of inevitability or logical completeness,[3] and principles of symmetry give the laws of physics their beauty (DFT: 134-137). These same qualities appear in some of the scientific-religious imagery as well. For Laws-*as*-God, symmetry principles "dictate" the forces of nature and make gravity and the existence of photon, W, and Z fields "necessary" (DFT: 142, 146). The following passage shows how Weinberg links beauty to the final theory:

> It is when we study truly fundamental problems that we expect to find beautiful answers. We believe that, if we ask why the world is the way it is and then ask why that answer is the way it is, at the end of this chain of explanations we shall find a few simple principles of compelling beauty. We think this in part because our historical experience teaches us that as we look beneath the surface of things, we find more and more beauty. Plato and the neo-Platonists taught that the beauty we see in nature is a reflection of the beauty of the ultimate, the *nous*. For us, too, the beauty of present theories is an anticipation, a premonition, of the beauty of the final theory. And in any case, we would not accept any theory as final unless it were beautiful.
>
> (DFT: 165)

Here, Weinberg claims the beauty of current theories only hints at the compelling and ultimate beauty of the final theory. Beauty represents, for Weinberg, a criterion for the final theory. In addition, Weinberg compares the beauty of the final theory to the beauty of the God-like ultimate *nous* (i.e., mind). Thus, Weinberg's sense of beauty ties in to Laws-*as*-God and the final theory by assuming God-like functions and qualities.

Weinberg develops the concept of beauty more than the other authors, and it represents a significant theme appearing along side the scientific-religious imagery. In some passages, beauty becomes part of Laws-*as*-God. In others, aesthetic imagery appears instead of scientific-religious imagery (e.g., the passage above discussing the beauty of the final theory (DFT: 165)). However,

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[3] What Weinberg means by "a sense of inevitability" is a kind of coherence and consistency to a theory. Such a theory, usually referred to as a "closed" theory, cannot be modified without introducing logical inconsistencies.

beauty and aesthetics do not contradict the scientific religious imagery. In other words, the concept of beauty in the final theory does not conflict with the image of the final theory as God.

Weinberg and 'God'

Dreams of a Final Theory requires some special treatment because of Weinberg's opposition to discussing God in relation to science. Weinberg thinks that "God," the "mind of God," etc., represent natural metaphors for a final theory because it addresses such fundamental issues (DFT: 242). However, Weinberg feels cosmologists tend to use the term 'God' too broadly. They present an image of God as abstract and disinterested, hardly distinguishable from the laws of physics. Weinberg argues that the generic use of 'God' in this manner renders the concept unimportant. He writes:

> It seems to me that if the word "God" is to be of any use, it should be taken to mean an interested God, a creator and lawgiver who established not only the laws of nature and the universe but also standards of good and evil, some personality that is concerned with our actions, something in short that is appropriate for us to worship. This is the God that has mattered to men and women throughout history. Scientists and others use the word "God" to mean something so abstract and unengaged that He is hardly to be distinguished from the laws of nature.
>
> (DFT: 244-245).

As we see, Weinberg presents three criteria for the typical religious conception of God: creator, lawgiver, and provider of moral standards. This last criteria, according to Weinberg, distinguishes God from the laws of physics. In other words, Weinberg believes a God personally interested in our actions would provide standards of morality. Weinberg does not seem to believe in an such a God:

> Religious people have grappled for millennia with the theodicy, the problem posed by the existence of suffering in a world that is supposed to be ruled by a good God. They have found ingenious solutions in terms of various supposed divine plans.... Remembrance of the Holocaust leaves me unsympathetic to attempts to justify the ways of God to man. If there is a God that has special plans for humans, then He has taken very great

> pains to hide His concern for us. To me it would seem impolite if not impious to bother such a God with our prayers.
>
> (DFT: 250-251)

In other words, an interested God would not allow suffering and would be more obvious in the world. So, it seems that Weinberg does not believe in a personal God -- the God he identifies with religion. In addition, Weinberg does not think the final theory will reveal a special status for life, standards of morality, or any sign of a concerned or interested God (DFT: 250-251). Weinberg stresses this last conviction, repeating it twice (DFT: 245, 256). Thus, it appears that Weinberg does not believe that cosmology can perform the religious functions that the scientific-religious imagery in his and the other texts suggests.

So, how should we interpret Weinberg's statements that a final theory will lead to knowledge of God or provide meaning and purpose to our lives in light of Weinberg's belief that the final theory will not do these things? I have already cited the following passages in Chapter 2, but will repeat them here. Regarding the final theory and knowledge of God, Weinberg states:

> If there were anything we could discover in nature that *would* give us some special insight into the handiwork of God, it would have to be the final laws of nature. Knowing these laws, we would have in our possession the book of rules that governs the stars and stones and everything else.
>
> (DFT: 242)

Weinberg also claims the following concerning the status of life and an interested God:

> If, on the other hand, we found some special role for intelligent life in the final laws..., we might well conclude that the creator who established these laws was in some way specially interested in us.
>
> (DFT: 251)

We need to remember what Weinberg means by God -- a God personally interested in our actions. As a result, the "handiwork of God" refers to signs of an interested God, which Weinberg states more clearly in the second quote. Given Weinberg's argument against the existence of an interested God, he does not feel the final theory will reveal anything about God. If the reader did believe

in an interested God, though, Weinberg seems to say that the final theory might provide knowledge about this God. Concerning a special status for life in the final laws, Weinberg also argues that the history of science shows a trend towards a "chilling impersonality in the laws of nature" (DFT: 245), and states:

> The first great step along this path was the demystification of the heavens. Everyone knows the key figures: Copernicus, who proposed that the earth is not at the center of the universe, Galileo, who made it plausible that Copernicus was right, Bruno who guessed that the sun is only one of a vast number of stars, and Newton who showed that the same laws of motion and gravitation apply to the solar system and to bodies on the earth.... Modern cosmologists even speak of a Copernican principle: the rule that no cosmological theory can be taken seriously that puts our own galaxy at any distinctive place in the universe.
>
> (DFT: 245-246)

Weinberg goes on to claim that science has "demystified" life as well (DFT: 246). Thus, Weinberg argues that scientific explanation removes any special status for humans in the universe. In fact, by invoking the "Copernican principle," Weinberg judges any theory that did contain a special status for life as invalid. Since Weinberg associates special status for life with evidence for an interested God (DFT: 251), this argument backs up his assertion that the laws of physics do not and will not reveal an interested God, contrary to what his statements (DFT: 242, 251) above suggest. As a result, Weinberg believes the laws of physics do not reveal any kind of special status for life, and he argues against the existence of the personal God of religion. However, according to Weinberg, if anything can prove him wrong, it is the final theory.

Yet, Weinberg's text includes scientific-religious imagery which gives cosmology religious functions. For example, Laws-*as*-God, the dominant image in Weinberg's text (see Appendix B), often takes over references to God's governance of the universe without specific references to God (as Weinberg tries to avoid). We see this in the passage above (DFT: 242) where the laws represent "the book of rules that governs the stars and stones and everything else." In other passages, Weinberg also discusses laws that "govern" the evolution of the universe and all physical phenomena (DFT: 34, 147). Further, these and other passages suggest that the laws transcend the physical universe

and possess God-like qualities. Weinberg states that symmetry principles "dictate" the forces of nature and make "necessary" gravity and the existence of particles (DFT: 142, 146). If we look at Weinberg's criteria for God, we see that his use of scientific-religious imagery does not present the laws as performing the role of a God personally interested our actions. The laws do not provide standards of good and evil.[4] However, Laws-*as*-God assumes functions of an impersonal God. Laws govern the universe, but do not contain any special place or concern for humans. Despite Weinberg's arguments against cosmology's ability to perform certain religious functions, the scientific-religious imagery in his text still gives cosmology religious roles. Thus, even though Weinberg specifically refrains from using 'God' metaphors, his text presents imagery related to Cosmology-as-Religion. Moving on, the following chapter discusses Cosmology-as-Religion's appropriation of religious authority and how this relates to the justification of cosmology.

[4] None of the other authors present laws as providing moral standards, but Weinberg is the only one to use such standards to distinguish a personal from an impersonal God.

CHAPTER 4: Appropriation and Justification

By describing cosmology with religious language, metaphors, and images and comparing cosmology to theology, the authors give the claims in their writings religious and spiritual dimensions. They create scientific-religious images (e.g., cosmologists as priests) that give cosmology traditional religious roles and present Cosmology-as-Religion. Thus, these religious appeals give cosmology religious functions, appropriating religious authority. Yet, why should we care if the authors' appropriate religious authority in their texts? The answer lies in another common theme: the justification of cosmology. The texts contain arguments for the significance of cosmology and the importance of continuing the cosmological quest. Sometimes, these arguments involve direct appeals for society's support (e.g., federal funding). The justificatory arguments focus on the same themes as the scientific-religious imagery (e.g., the cosmological quest, a final theory, the God particle). In addition, the arguments appear in sections of the texts with high frequencies of scientific-religious imagery. Because of this, I argue the texts link the justificatory arguments to the religious appeals. This associates the scientific-religious imagery's appropriation of religious authority with the justificatory arguments. As a result, the appropriated religious functions provide a social and cultural context to the arguments by giving cosmology social value which increases cosmology's importance to society. Below, I turn to scholarship in science and technology studies, especially the work of Evelyn Fox Keller, to illuminate how the religious appeals appropriate religious authority. After this, I present the justificatory arguments that appear in the texts and demonstrate how the scientific-religious imagery supports them.

Appropriation of Religious Authority

Other work in science and technology studies on appropriation uses the term to describe the borrowing of language, metaphors, theories or concepts, moral force, and social or cultural authority. Often, this process transforms and distorts what it appropriates. When Cosmology-as-Religion gives cosmology and cosmologists religious roles, it appropriates religious authority, but it also transforms these roles so that cosmological answers based on scientific

knowledge -- instead of answers based on faith or theology -- fulfill the appropriated functions. Work in science and technology studies reveals similar appropriations in other areas. For example, Evelyn Fox Keller's studies of nuclear weapons research and the development of molecular biology prove relevant. In "From Secrets of Life to Secrets of Death," Keller describes the male appropriation of female procreativity in these two areas. Here, physicists and biologists attempted to appropriate a function or secret previously controlled by women, paralleling cosmology's attempt to take over religious roles.

According to Keller, metaphors of pregnancy and birth which surrounded the development and testing of nuclear weapons displaced the mother from the life-giving process.[1] For example, the atomic and hydrogen bombs became known as Oppenheimer's and Teller's babies, respectively.[2] Further, the male-dominated secrecy surrounding this research, Keller claims, produced a closed, male community which gave birth to these "babies." These babies do not have mothers, only fathers (Keller, 1990a, 43-45).[3] Moving to molecular biology, Keller argues that the discovery of DNA, described by molecular biologists as the search for "the secrets of life," successfully co-opted female procreativity. Here, Keller argues that by using the language of physics, molecular biologists essentially redefined what biology could address. As a result, they appropriated the authority of physics to create a new physics-like attitude that science should unravel the mysteries of life (Keller, 1990a, 41-43). Keller then describes how this new attitude produced molecular mechanics which displaced the secrets of life, removing any flesh and blood or maternal references from discussions of life. In both cases, Keller argues that the male appropriation represented an

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[1] Keller cites (Easlea, 1983) as documenting the birth imagery surrounding the first atomic and hydrogen bombs.

[2] Carol Cohn also discusses the male birth imagery in the language of nuclear strategists, including a quote from General Holloway, former commander in chief of the Strategic Air Command, who described nuclear war as involving "a big bang, like the start of the universe" (Cohn, 1987, 701-702).

[3] The primary texts of this study also contain some male birth imagery. The Cosmologists-as-Gods image contains cosmologists creating "toy universes." In addition, the creators name these universe after themselves; the universes represent the progeny of their creators (see p. 38).

attempt to control the secrets of life -- secrets traditionally held by women in virtue of their ability to give birth. Nuclear weapons converted this control over life into a destructive force (inverting the secrets-of-life metaphor into one of the secrets-of-death) while molecular biology assumes control over these secrets by devivifying procreativity (i.e., removing reference to flesh and blood which displaces the role the feminine life-giving power) (Keller, 1990a, 45, 51-52).

Keller's work bears a relation to this study: the male appropriation of female procreativity speaks to the cosmological appropriation of religious functions. Both give science roles formerly held by another entity. In addition, the appropriation of these functions represents an attempt to gain access to and control of "secrets" of other domains. As cosmology assumes religious functions, it attempts to answer questions previously handled by religion. For example, cosmology provides meaning and purpose to our lives. The cosmological quest and search for a final theory offer the possibility of answering the questions of 'why does the universe exist?' and 'why do we exist?' In addition, some of the authors, like Davies and Smoot, suggest the search itself (i.e., the practice of cosmology) gives them a sense of meaning and purpose to our existence by increasing our understanding of the universe (MG: 16) (WT: 295). Weinberg also describes a sense of spiritual satisfaction some scientists get from their work (DFT: 256). Further, cosmology produces and interprets myths. In another recurring theme, cosmology and cosmologists enjoy access to divine knowledge and God. The scientific-religious imagery, paralleling the appropriation of female procreativity by weapons research and molecular biology, appropriates traditional religious functions. As a result, cosmology assumes control of the secrets of the universe, our existence, and God.

Beyond this, some of the authors actually discuss cosmology's take-over of knowledge areas traditionally controlled by religion, asserting cosmology's ability to assume these roles. This contrasts with the molecular biologists and nuclear physicists in Keller's study; they did not explicitly claim to be appropriating female procreativity. According to Hawking, Edwin Hubble's discovery of the expanding universe extended the boundaries of science to questions concerning the beginning of the universe (BHT: 8). In addition, Hawking provides the following

argument justifying cosmology's attempt to find laws describing the beginning of the universe:

> The eventual goal of science is to provide a single theory that describes the whole universe. However, the approach most scientists actually follow is to separate the problem into two parts. First, there are laws that tell us how the universe changes with time.... Second, there is the question of the initial state of the universe. Some people felt that science should be concerned with only the first part; they regard the question of the initial situation as a matter for metaphysics or religion. They would say that God, being omnipotent, could have started the universe off any way he wanted. That may be so, but in that case he also could have made it develop in a completely arbitrary way. Yet it appears that he chose to make it evolve in a very regular way according to certain laws. It therefore seems equally reasonable to suppose that there are also laws governing the initial state.
>
> (BHT: 10-11)

Hawking asserts that cosmology can indeed address the question of the universe's initial state. Barrow also presents a view similar to Hawking's, stating "the traditional view that initial conditions are for theologians and the laws of change for the physicists seem to have been clouded -- at least temporarily" (OU: 109). Davies also argues that cosmology deals with areas formerly handled by religion:

> In later years I began doing research on topics like the origin of the universe, the nature of time, and the unification of the laws of physics, and I found myself trespassing on territory that for centuries had been the near exclusive province of religion. Yet here was science either providing answers to what had been left as dark mysteries, or else discovering that the very concepts from which those mysteries drew their power were actually meaningless or even wrong.
>
> (MG: 13-14)

In this passage, Davies argues that science actually does a better job addressing these issues, justifying cosmology's move into religious subjects. In other passages, Davies reinforces this idea, stating that any understanding of our place in the universe *must* involve science (see (MG: 21) on p. 41). These

arguments show cosmology taking over religious functions, attempting to control the secrets of the universe in the same way molecular biology and nuclear weapons research attempted to control the secrets of life, according to Keller. However, contrasting with the scientists in Keller's study, the cosmologists announce their take-over.

Cosmology-as-Religion gives cosmology religious roles, appropriating religious authority over these functions. As a result, the scientific-religious imagery helps legitimate the authors' claims that cosmology can perform these roles, which concern issues of meaning, purpose, and God. Again, I turn to Keller for insights. Keller argues that molecular biologists appropriated the social authority of physics through, in part, the use of similar language and analogies between molecular biology and physics. Feeding off the social status that physics enjoyed after World War II, biologists like Watson and Crick appropriated physics' authority by adopting the language, attitude, and methods of physics. As a result, according to Keller, this helped legitimate molecular biology's claim that genetic replication contained the secrets of life and that these secrets resided in the domain of molecular biology (Keller, 1990b, 390, 406). Similarly, cosmology legitimates its claim to knowledge about God and the meaning of life through the scientific-religious imagery created in the popular texts. To create this imagery, the texts both adopt the language of religion and compare cosmology to religion (e.g., see Smoot's claim that cosmology provides society with creation myths or the use of Cosmologists-as-Priests as well as positioning tactics (pp. 43-45, 26-40, 45-47)). Thus, the scientific-religious imagery appropriates religious authority, legitimating cosmology's attempt to gain access to areas of knowledge traditionally controlled by religion.

Christopher P. Toumey also writes about the appropriation of scientific authority, providing another example of how cosmology appropriates religious authority. Toumey's analysis of creationist movements describes how scientific creationism, in contrast to other creationist movements, embraces science. Toumey argues that the success of scientific creationism over competing creationist movements results from the successful appropriation of science's authority. According to Toumey, the scientific creationists use scientific terminology and theories to co-opt popular cultural symbols of science which

help legitimate their claims (Toumey, 1991, 692, 695). We find the same type of relationship between science and religion in cosmology except the appropriation goes in the opposite direction: science appropriates religious authority through the use of religious imagery and language. As a result, this helps legitimate cosmology's attempt to perform religious functions.[4]

Looking at the frequency of scientific-religious imagery in the primary texts, we find that the texts contain concentrated areas of scientific-religious imagery around cosmology's assumptions of religious functions. Thus, the location of the imagery in the texts facilitates the appropriation of religious authority. For example, while discussing how cosmology can provide meaning to our lives, Smoot compares cosmology to religious creation myths, compares the big bang to the Christian idea of creation out of nothing, and talks about the mystical qualities of big bang theory (WT: 17-18). Smoot also uses a great deal of scientific-religious imagery in his concluding discussion of the cosmological quest to understand the universe and our place in it (see (WT: 296-297) on pp. 77-78). In these sections, cosmology offers meaning and purpose to our lives through creation myths and by defining a role for humans in the universe. Further, they occur in the two chapters with the highest frequency of scientific-religious imagery (see Appendix B for page counts of scientific religious imagery). We find similar situations with the other authors as well.

Barrow's use of scientific-religious imagery is concentrated in three small sections concerning the following issues: the fate of the universe (i.e., whether the universe will expand forever or eventually contract to a "big crunch") (OU: 24-29); quantum cosmology and the creation of the universe (OU: 109-113); and the

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[4] Robert K. Merton also discusses the appropriation of scientific authority through the use of scientific language and theories. In Merton's case, he was specifically referring to totalitarian governments of the 1930's and 40's and their (mis)use of science to advance self-serving claims. In any case, Merton states that, because of the specialization of scientific knowledge, the lay public cannot make informed decisions regarding scientific claims. As a result, the lay public is susceptible to disingenuous claims that use scientific language to appropriate scientific authority -- authority gained through science's achievements (Merton, 1938, 264) (Merton, 1942, 277). Religious vocabulary serves a similar, though less sinister, function for cosmology in its lay literature, borrowing religion's authority over topics concerning the meaning and purpose of life, divine knowledge, and God. These topics represent the secrets of religion and lie outside the lay public's control. As a result, the authors can appropriate religious authority to justify their claims.

existence of life (OU: 124-128). In these sections, the scientific-religious imagery gives cosmology several religious functions. Positioning tactics present cosmological theories as creation myths,[5] the Laws-*as*-God metaphor offers cosmology as a way to obtain knowledge of God, and Barrow defines a role for human intelligence to provide meaning and purpose to our lives (see Appendix B).

Similarly, the scientific-religious imagery in Hawking's text appears more frequently around issues concerning a final theory and the creation of the universe. In his first chapter, Hawking uses positioning tactics and Laws-*on/as*-God to present cosmology as superseding religion (i.e., cosmology takes over the roles of providing knowledge of God or some other supreme agency and knowledge of the creation of the universe), concluding with an argument justifying cosmology and its quest for a theory of everything (BHT: 7-13). In Chapter 8, "The Origin and Fate of the Universe," Hawking frequently uses scientific-religious imagery and includes many references to God. He also presents cosmology as a means to knowledge of God in this section (BHT: 122-123, 125, 127, 136, 140-141). Regarding a final theory, we see another concentration of scientific-religious imagery (BHT: 166-169). Here, Hawking claims science may enable us to know the mind of God and give us a complete understanding of the universe and our existence. Finally, in his conclusion, Hawking again presents Laws-*on/as*-God taking over the role of the Creator, ending with his passage linking the final theory to the mind of God (BHT: 174-175) (see Appendix B). With all of these authors, the increased use of scientific-religious imagery coincides with cosmology's assumption of religious functions.

Turning to Davies, a consistent theme in *The Mind of God* concerns cosmology's ability to address questions previously controlled by religion. The use of scientific-religious imagery that grants cosmology religious functions, then, complements Davies' argument. Scientific-religious imagery appears throughout Davies' text, except for some chapters on mathematics with fewer instances. Similar to the authors discussed above, Davies' discussions of meaning and

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[5] Positioning tactics refer to the authors' presentation of cosmological theories in relation to theological issues (see pp. 45-47).

purpose and the creation of the universe tend to appear in chapters with high frequencies of scientific-religious imagery (see Appendix B).

Looking specifically at the positioning of scientific and theological ideas provides an example of how scientific-religious imagery gives cosmology religious functions. Through positioning tactics, the authors implicitly present cosmological theories as contemporary versions of theological ideas and compare cosmology to theology. This asserts cosmology's ability to address theological issues and presents cosmology as superseding religion (see pp. 45-47). Since Davies discusses science and religion openly in his text, he uses more explicit positioning techniques. So, Davies not only introduces cosmological ideas with comparable religious concepts, but he also refers back to the religious concepts. In other words, Davies discusses cosmology and theology together, comparing and contrasting them. We find that Davies' positioning moves occur around discussions of the creation of the universe (see Appendix B).

In Chapter 2 of *The Mind of God*, "Can the Universe Create Itself?," six out of eight sections discuss theological issues. Further, the entire chapter uses positioning techniques (i.e., positioning occurs in the individual sections and between the sections themselves), discussing theological and cosmological theories about the creation of the universe. Davies introduces religious concepts concerning cyclic universes, the nature of time, and creation out of nothing, and then relates scientific theories to these religious ideas. Looking at section titles throughout the text, the term 'God' appears most frequently in Chapter 7, "Why is the World the Way it Is?," in four out of 10 sections.[6] This chapter discusses limits or restrictions in the creation of the universe -- "whether God had any choice in creating the world" (MG: 161). As with Chapter 2, we find a high concentration of positioning and theological issues (see Appendix B), occurring in five out of the ten sections (four of these five sections include 'God' in the section headings) (MG: 177-193). In these sections, Davies discusses topics like creation out of nothing, process theology, and God as a necessary being in

[6] This compares with 'God' in one section title in Chapter 2 and two sections out of eight in Chapter 8 (one title includes 'Creator' and the other 'Designer'). No other section titles in the text include references to 'God,' 'Creator,' 'Designer,' etc.

relation to cosmological theories. Davies also mentions theology in other sections (MG: 162, 171). We find, then, that Davies' positioning tactics appear more frequently in the two chapters dealing with the creation of the universe.

By comparing cosmological theories to religious concepts, Davies asserts cosmology's ability to perform certain religious functions. Specifically, cosmology can provide knowledge about the creation of the universe and why we live in the universe we observe today. Interestingly, in Chapter 8, "Designer Universe," the positioning references to theology decrease dramatically compared to Chapters 2 and 7 (see Appendix B). In Chapter 8, Davies discusses whether the study of nature can reveal anything about a necessary being (i.e., God) (MG: 193). Moving away from explicit references to theology, Davies goes through the physical properties of nature discovered by science (e.g., order, coherence, uniformity, simplicity), and he looks at cosmological arguments for and against an intentionally designed universe. Further, near the end of the chapter, Davies states his belief that the qualities of nature (e.g., ingenuity, beauty, economy), revealed through the laws of physics, transcend reality, and that one could conceive of God as a personification of these qualities (see (MG: 214-215) on pp. 22-23). So, Chapter 8 represents cosmology's assumption of religious duties. In other words, Davies discusses God and the universe in terms of physics without references to theology. The positioning in the previous chapters concerning the creation, then, helps legitimate cosmology's move in Chapter 8.

Lederman and Weinberg's use of scientific-religious imagery and cosmology's assumption of religious functions occur most frequently in discussions of the main themes of their texts: the God particle and the final theory, respectively. The scientific-religious imagery in Lederman's text focuses on cosmology's assumption of religious duties laid down in the Very New Testament. Here, we see Lederman's most striking imagery of the SSC as the Tower of Babel and the God particle as God's divine agent (GP: 24, 342-343) (see Appendix A for the Very New Testament passages and Appendix B for page counts and a discussion of scientific-religious imagery), and cosmology performs religious functions concerning knowledge of God. In these sections, cosmology learns about God through an increased understanding of the universe, which is presented as God's creation. In terms of the Very New Testament, we learn

about God through the God particle. In addition, Lederman compares the entire scientific endeavor to the construction of the Tower of Babel, getting closer to God and "the ultimate revelation" (GP: 407). Finally, Lederman's text, *The God Particle*, focuses on the Higgs particle, which Lederman names the *God* particle.

Weinberg focuses on a final theory, and his most frequent use of scientific-religious imagery occurs in two chapters about the final theory. Chapter 9 discusses string theory as a possible final theory and what a final theory needs to explain. In Chapter 11, Weinberg discusses the final theory and God. In both chapters, most of the scientific-religious imagery presents Laws-*as*-God. In fact, Laws-*as*-God represents the dominant image throughout the text (See Appendix B). As I discussed in Chapter 2, Laws-*as*-God gives cosmology the role of providing divine knowledge. Thus, Weinberg employs Laws-*as*-God primarily around the final theory, which presents cosmology and cosmologists as learning about God.

These concentrations of scientific-religious imagery around the appropriation of religious functions helps make the appropriation of religious authority in the texts successful. In short, it adds weight to cosmology's claim over these knowledge areas. We see that the scientific-religious imagery varies in concentration with some sections containing little or no scientific-religious imagery. Many of these sections deal with technical descriptions of experiments, explanations of the physics of cosmology, and the history of science (see Appendix B). On the other hand, when the authors discuss the ultimate questions (e.g., how and why did the universe begin, why are we here, and what is our place in the universe?), the use of scientific-religious imagery increases. Further, in these same passages, when the authors discuss the ultimate questions with scientific-religious imagery, cosmology takes over religious functions (e.g., we have Laws-*as*-God creating the universe and cosmology offering meaning and purpose to our lives through myth).

The religious appeals in the texts, then, help appropriate religious authority. Similar to the male appropriation of female procreativity discussed by Keller, cosmology appropriates religious functions through the scientific-religious imagery in the texts. As a result, Cosmology-as-Religion gives cosmology the authority to assume religious functions and address the secrets of the universe

and God -- secrets traditionally held by religion. Now, the texts also include arguments justifying cosmology and appealing to society for continued support. Below, I argue that the texts link the scientific-religious imagery to their justificatory arguments and claim that the model of Cosmology-as-Religion further legitimates cosmology by strengthening the justificatory arguments.

Justification of Cosmology

This section demonstrates how the texts associate the scientific-religious imagery with arguments justifying cosmology. Through this link, the scientific-religious imagery's appropriation of religious functions provides a social context to the justificatory arguments. The appropriated functions give cosmology social value which increases its importance to society. As a result, the religious appeals strengthen the justificatory arguments.

All of the primary sources, in one way or another, justify cosmology, but they differ in the scope and directness of their arguments. Some of the authors appeal directly for continued support, while others use more implicit arguments. In part, these differences arise out of the texts' varied purposes. Weinberg and Lederman were directly involved in the SSC funding debates.[7] As a result, both texts focus on the SSC and spend a large amount of time justifying cosmology. At the other end of the spectrum, Barrow attempts a brief introduction to cosmology and the history of the universe according to contemporary big bang theory for first-time readers. Barrow does not argue for continued support, but instead, implicitly justifies cosmology by presenting it as progressing towards an understanding of the secrets of the universe. Smoot, Davies, and Hawking lie in the middle, but Smoot gives arguments closer to Weinberg's and Lederman's than Davies or Hawking.

Despite the differences, however, common themes emerge. The texts stress the significance of HEP (high energy physics) to the early universe and big bang theory. With Weinberg, Lederman, and Smoot, this increases the importance of the SSC and helps to justify its construction. In addition, historical and socio-economic arguments call for continued support based on cosmology's past

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[7] Both Lederman and Weinberg testified before Congress (Kevles, 1995, xvi, xvii).

success and technological, social, and economic benefits. Finally, the justificatory arguments focus on the quest for a final theory, answers to the ultimate questions, the God Particle and the SSC, etc. -- the same subjects around which the authors build the scientific-religious imagery. Because of this, the justificatory arguments become linked to the religious imagery in the texts and gain strength from the appropriation of religious functions and authority.

In his text, Weinberg argues for continued SSC funding, stressing the SSC's importance to HEP and cosmology. According to Weinberg, theoretical HEP has surpassed its experimental capabilities, and this situation is preventing HEP from advancing towards a final theory (DFT: 4, 274). Weinberg claims the SSC will break this impasse, but failure to complete the project will signify the abandonment of HEP's search for the final laws of nature (DFT: 210, 234, 275). Weinberg believes the SSC will advance HEP for the following reasons (DFT: 210, 235, 269):

- it will discover the electroweak symmetry breaking mechanism (either Higgs particles or new strong forces)
- it might produce information that leads to a final theory
- it will test supersymmetry
- if particles exist within quarks, it might find them
- it might find new kinds of interactions associated with new symmetries

No matter what, Weinberg argues that data from the SSC will advance HEP, and may help produce a final theory in our lifetime (DFT: 210, 235). In addition, Weinberg links the SSC to cosmology via dark matter, claiming the SSC might produce a new kind of long-lived particle with enough mass and in large enough quantities to account for the unknown dark matter. Further, Weinberg states these new particles might also explain the questions of galaxy formation left unanswered by COBE (DFT: 267-269). In other passages, Weinberg re-states HEP's importance to cosmology (DFT: 33, 57).

Beyond this, Weinberg also includes socio-economic and historical arguments for the SSC. First, Weinberg claims the SSC will keep high-energy physicists in the United States who would otherwise be forced to conduct research at accelerators in Europe and Japan. He then states that the physics community has served the United States in the past, citing the Manhattan project

during World War II and recent advances in parallel programming for supercomputers. In addition, Weinberg argues that construction of the SSC will produce technological advances in industries related to cryogenics, magnet design, and on-line computing (DFT: 273-274). Finally, Weinberg provides a historical argument based on the past success of science, noting that higher accelerator energies have usually produce new and revealing phenomena (DFT: 266). For these social and historical reasons, Weinberg argues for the SSC.

Weinberg also includes a "past success" argument based on what he calls arrows of explanation. According to Weinberg, sciences advances as chains of explanations reach deeper, more fundamental levels. For example, chemical interactions can be explained in terms of protons, neutrons, and electrons. Moving to a more fundamental level, the interactions of these particles can then be explained in terms of quarks. Using this reasoning, Weinberg believes these arrows of explanation (i.e., chains of explanations leading to more fundamental truths of nature) are converging at contemporary physics (e.g., chemistry and biology can presumably be reduced to the interactions of elementary particles contained in the Standard Model) and will eventually converge to a few principles representing the final theory (DFT: 29-32, 165). In other words, the past explanatory success of science, according to Weinberg, warrants belief that cosmology will achieve a final theory.

Now, how do these arguments tie into the religious appeals? Looking at the location of the justificatory arguments, we find they tend to occur in chapters without scientific-religious imagery (see Appendix B). Therefore, location in the text does not link the imagery to the arguments. However, Weinberg's text focuses on the final theory, and except for the spin-off technologies and socio-economic benefits, so do the justificatory arguments. Weinberg claims that cosmology needs the SSC to continue the quest for the final laws. Chapter 2 discussed how Weinberg's presentation of a final theory and the laws of nature uses religious imagery. Weinberg writes about the laws of physics as though they transcend the physical world and take on God-like roles -- Laws-*as*-God. For example, laws take over the governance of the universe; they "govern" the evolution of the universe and all physical phenomena (DFT: 34, 147). This adds a different dimension to the justificatory arguments. Even though Weinberg

believes that the final theory will not produce any knowledge of God (DFT: 245) (see pp. 56-59), the final theory -- the set of laws that govern the universe -- becomes more important through its God-like attributes. As a result, when Weinberg discusses the SSC's importance for the quest for the final laws, the SSC becomes a means to acquire the God-like agency embodied in the final theory as Weinberg presents it. This provides another social benefit in addition to the ones presented in Weinberg's socio-economic arguments.

Lederman also argues for the SSC, but where Weinberg focuses on a final theory, Lederman seeks the God particle. Lederman gives scientific reasons for the SSC, noting it might discover the Higgs particle and will test supersymmetry (GP: 365-366). In addition, the SSC will produce synchrotron radiation (as a side-effect) which biologists can use in their research. We also see historical arguments related to socio-economic benefits and the past success of accelerator research. Lederman claims Fermilab's use of superconducting magnets in the 1970's significantly advanced the magnet industry. Today, Lederman notes, this industry supplies the majority of its magnets to firms making medical resonance imaging devices (MRI's) used for medical diagnosis (GP: 234). Also, Lederman points out that hospitals across the country use cyclotrons, the predecessors to today's accelerators (GP: 217). Thus, according to Lederman, past accelerator development and construction has led to socio-economic benefits. Finally, Lederman states that HEP built the Standard Model around data produced in accelerators, emphasizing the past success of accelerator research (GP: 21-22).

Like Weinberg, Lederman discusses the SSC in relation to cosmology and big bang theory. The inflationary model of the big bang predicts a period of rapid expansion in the early stages of the universe. According to Lederman, the Higgs field provides a mechanism for the inflated expansion (GP: 397-400). So, the SSC, by discovering the Higgs particle, will provide more evidence for inflation theory and help cosmology.

Both Lederman's justification of cosmology and development of scientific-religious imagery revolve around the SSC and God particle. As we have seen, Lederman specifically ties the SSC into the religious images with his "Very New Testament" and metaphors of the SSC as the Tower of Babel, a time machine,

and a cathedral. Lederman uses the time machine metaphor to discuss HEP's role in cosmology as well as the Higgs particle's importance to the early universe. He expands on Robert Wilson's cathedral metaphor, claiming accelerators provide spiritual uplift, transcendence, and revelation, and also casts cosmologists in the role of priests (GP: 253-255). In addition, Lederman links cosmology, the God particle, and the SSC to the Tower of Babel image with his Very New Testament. Consider the following passage which contains the Very New Testament's revision of Genesis 11:1-9 (which Lederman includes on the page preceding the following quote, see Appendix A for the Genesis passage):

> [Particle physicists and astronomers] have been progressing toward a simple, coherent, all-encompassing model that will explain everything: the structure of matter and energy, the behavior of forces in environments that range from the earliest moments of the infant universe with its exorbitant temperature and density to the relatively cold and empty world we know today. We were proceeding nicely, perhaps too nicely, when we stumbled upon an oddity, a seemingly adversarial force afoot in the universe. Something that seems to pop out of the all-pervading space in which our planets, stars, and galaxies are embedded. Something we cannot yet detect and which, one might say, has been put there to test and confuse us. Were we getting too close? Is there a nervous Grand Wizard of Oz who sloppily modifies the archaeological record?
>
> The issue is whether physicists will be confounded by this puzzle or whether, in contrast to the unhappy Babylonians, we will continue to build the tower and, as Einstein put it, "know the mind of God."
>
> > And the whole universe was of many languages, and of many speeches.
> >
> > And it came to pass, as they journeyed from the east, that they found a plain in the land of Waxahachie, and they dwelt there. And they said to one another, Go to, let us build a Giant Collider, whose collisions may reach back to the beginning of time. And they had superconducting magnets for bending, and protons had they for smashing.

> And the Lord came down to see the accelerator, which the children of men builded. And the Lord said, Behold the people are unconfounding my confounding. And the Lord sighed and said, Go to, let us go down, and there give them the God Particle so that they may see how beautiful is the universe I have made.
>
> -- The Very New Testament, 11:1

(GP: 24)

Thus, Lederman compares the SSC to the Tower of Babel. However, this time God reveals the beauty of the universe to the scientists via the Higgs particle -- physicists, and mankind, do not suffer the fate of the "unhappy Babylonians." This passage also presents the Laws-*of*-God image, and implies that cosmology, as it progresses toward a final theory, reveals God's plan or design. At the close of *The God Particle*, Lederman compares the entire scientific endeavor to the Tower of Babel, using this metaphor in a broader sense. Believing that physics will achieve a final theory, Lederman worries "about the necessary sense of optimism that our society must summon if this quest is to continue" (GP: 408). Adding to this, these arguments appear in chapters with high frequencies of scientific-religious imagery. So, the arguments' location coincides with concentrated areas of imagery, strengthening the link between them. In addition, most of Lederman's scientific-religious imagery follows the theme presented in the Very New Testament: cosmology provides knowledge of God (see Appendix B). As a result, through the SSC, God particle, and laws of physics, Lederman ties his justificatory arguments to the scientific-religious imagery in his text.

Through this link, Lederman adds strength to his justificatory arguments. Beyond the possible technological spin-offs and economic benefits, the SSC will allow cosmologists to obtain knowledge of God and reveal the beauty of our universe. Further, the SSC will, according to Lederman, advance science on its quest for a final theory. As we have seen, Lederman believes cosmology will complete the quest if it gets enough support from society. In other words, with enough funding, cosmology will obtain a final theory and know the mind of God. The scientific-religious imagery adds to the social benefits produced by cosmology. So, for Lederman and Weinberg, the scientific-religious imagery adds to the cultural benefits of cosmology. Giving cosmology religious functions,

the scientific-religious imagery creates a social context beyond socio-economic benefits. This socio-*religious* context increases cosmology's importance to society.

Moving to *Wrinkles in Time*, Smoot focuses on the cosmological quest, but he also argues for the SSC, stressing its role in cosmology. Smoot believes the SSC may solve big bang theory's baryogenesis problem (WT: 111-112).[8] He also claims the SSC will test unification theories (WT: 94). In addition, Smoot believes the cosmological quest unites astrophysics and particle physics. The following example comes from the concluding pages of *Wrinkles in Time* and shows the quest as a combination of astrophysics and HEP:

> The quest will continue, with the dual goals of discovering dark matter and understanding the origin of space-time. No one knows where the answers will come from, but if recent history is any guide, a combination of observational science and particle physics will be important. More satellite ventures are planned, and the superconducting supercollider (SSC), one of the boldest scientific endeavors of all time, is under construction in Texas. Without doubt it is expensive -- perhaps as much as ten billion dollars. But the history of this science has been driven by the development of instrumentation. There may be no other way of understanding the first instants of creation than by re-creating big bangs of sorts in a massive machine like the fifty-four-mile circumference supercollider. As a culture, we have to decide whether the intellectual quest toward the ultimate question is worthwhile. The more we know about the history of the universe, the more we know about ourselves and the questions we are driven to ask.
>
> (WT: 295)

Thus, Smoot presents the SSC and future satellite missions like COBE as essential to the quest. The paragraph also includes arguments claiming history shows that HEP and astronomy produce cosmological advances, and HEP needs massive instruments like the SSC. Indeed, according to Smoot, the SSC

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[8] Baryogenesis refers to the production of excess matter over antimatter in the early universe. Some process like this must have occurred since our visible universe consists predominantly of matter. Smoot believes the SSC energies may be high enough to detect baryogenesis.

may be the only way to understand the early moments of the universe. Further, Smoot includes an appeal to society for support. We also see a time machine metaphor with cosmologists re-creating big bangs (or "little bangs" (WT: 94, 97, 109)) that also presents an image of Cosmologists-as-Gods. Finally, in the last sentence, Smoot discusses the quest and how he believes that cosmology provides understanding about ourselves and our place in the universe. This ties into Cosmology-as-Myth and the idea that cosmology provides meaning and purpose to our lives. By linking projects like the SSC and satellite missions to the cosmological quest, Smoot ties his justification of cosmology to the model of Cosmology-as-Religion presented in the texts.

The last three paragraphs of *Wrinkles in Time* provide another example of HEP and astronomy's link to the quest and includes several of the scientific-religious images:

> To me the universe seems quite the opposite of pointless. It seems that the more we learn, the more we see how it all fits together -- how there is an underlying unity to the sea of matter and stars and galaxies that surround us. Likewise, as we study the universe as a whole, we realize that the "microcosm" and the "macrocosm" are, increasingly, the same subject. By unifying them, we are learning that nature is as it is not because it is the chance consequence of a random series of meaningless events; quite the opposite. More and more, the universe appears to be as it is because it *must* be that way; its evolution was written in its beginnings -- in its cosmic DNA, if you will. There is a clear order to the evolution of the universe, moving from simplicity and symmetry to greater complexity and structure. As time passes, simple components coalesce into more sophisticated building blocks spawning a richer, more diverse environment. Accidents and chance, in fact, are essential in developing the overall richness of the universe. In that sense (although not in the sense of quantum physics), Einstein had the right idea: God does not play dice with the universe. Though individual events happen as a matter of chance, there is an overall inevitability to the development of sophisticated complex systems. The development of beings capable of questioning and understanding the universe seems quite natural. I would be quite surprised if such intelligence has not arisen many places in our very large universe.

> As I travel the world, I love to visit great art museums, to see classic sculptures, the works carved and painted and assembled by centuries of aesthetic visionaries. Cosmologists and artists have much in common: Both seek beauty, one in the sky and the other on canvas or in stone. When a cosmologist perceives how the laws and principles of the cosmos begin to fit together, how they are intertwined, how they display a symmetry that ancient mythologies reserved for their gods -- indeed, how they imply that the universe *must* be expanding, *must* be flat, *must* be all that it is -- then he or she perceives pure, unadulterated beauty.
>
> The religious concept of creation flows from a sense of wonder at the existence of the universe and our place in it. The scientific concept of creation encompasses no less a sense of wonder: We are awed by the ultimate simplicity and power of the creativity of physical nature -- and by its beauty on all scales.
>
> (WT: 296-297)

This passage shows Smoot's idea that particle physics and astronomy are converging to an understanding of the universe (i.e., the end of the quest). Elsewhere, he claims this convergence reveals itself in the increasing simplicity and symmetry within the laws of physics, and states that, because of this, he believes cosmology will one day understand "the very essence of creation" (WT: 290-291). Smoot's idea of convergence closely parallels Weinberg's argument based on arrows of explanation. In addition, Smoot brings up issues of meaning and purpose to our existence. If what cosmology discovers about nature shows the opposite of meaningless events, then the universe must be meaningful. Further, according to Smoot, our existence seems natural and is, in fact, inevitable. Intelligent life fits into the grand scheme of the universe. The use of Einstein's quote about God also reinforces the idea that cosmology enables us to understand and know God via the laws of physics. Finally, the last two paragraphs touch on other themes discussed in Chapter 2. Comparing cosmologists to artists, Smoot compares cosmologists to gods as they uncover the "unadulterated beauty" of the universe. The final paragraph touches upon Smoot's idea that cosmology provides us with creation myths as he compares cosmology's concept of creation to that of religion.

Smoot argues for continued support in terms of scientific-religious imagery. For example, the SSC and satellites will help us understand the meaning of life, and the convergence of HEP and astronomy brings us closer divine knowledge. Further, the two main arguments (WT: 295, 296-297) occur in the final chapter which contains a relatively high concentration of scientific-religious imagery (see Appendix B), strengthening the association of the justificatory arguments to the cosmological quest. Cosmology provides meaning and purpose to our lives by defining our place in the universe and supplying modern creation myths, allowing us to know more about ourselves as our understanding of the universe increases. Continued funding of satellites and other projects like the SSC allows cosmology to continue fulfilling these functions. Without the scientific-religious imagery, Smoot's arguments rely on the advancement of physics, but this leaves out why the advancement of physics is important to society. The scientific-religious imagery gives social value to the quest and strengthens the justificatory arguments by making cosmology socially important.

Davies, Hawking, and Barrow do not develop justificatory arguments like the other authors. However, their texts still include justifications of cosmology related to the scientific-religious imagery. Davies mentions the SSC and the Higgs particle, but does not appeal to society for support (MG: 208-209). Instead, historical arguments justify cosmology for Davies. Look at the following two examples:

> As a professional scientist I am fully committed to the scientific method of investigating the world. I believe that science is an immensely powerful procedure for helping us to understand the complex universe in which we live. History has shown that its successes are legion, and scarcely a week passes without some new progress being made.
>
> (MG: 14)
>
> When it comes to addressing the really deep issues of existence, such as the origin and meaning of the universe, the place of human beings in the world, and the structure and organization of nature, there is a strong temptation to retreat into unreasoned belief. Even scientists are not immune from this. Yet there is a long and respectable history of attempts to confront such issues by rational and dispassionate analysis [i.e., science].

(MG: 20)

Davies justifies the cosmological quests with the past success of cosmology and the scientific method. In addition, the second quote shows the link of this argument to the religious imagery in the text: "the really deep issues of existence" (i.e., the ultimate questions). Davies follows the second quote with another passage linking his past success argument to the scientific-religious imagery (see (MG: 21) on p. 41). Here, Davies claims that "humans have been written into the laws of nature in a deep and, I believe, meaningful way," and then states "any attempt to understand...the place of humans in the universe must proceed from a sound scientific base." Thus, cosmology does not just provide meaning and purpose by defining a role for humans in the universe, but is *required* for such an understanding. Davies' imagery also presents cosmology as providing access to God. According to Davies, his scientific work has led him to believe in a God-like "deeper level of explanation" and transcendent qualities in the laws of physics -- Laws-*as*-God (MG: 16, 214). These arguments also appear in chapters with significant amounts of scientific-religious imagery (see Appendix B). Thus, by location in the texts, the arguments and imagery become linked. Further, Davies uses positioning tactics to assert cosmology's ability to address the creation of the universe in Chapters 2 and 7 of *The Mind of God*, and in Chapter 8, Davies presents the study of nature as a means to divine knowledge (see pp. 67-68). So, in Davies' text, cosmology performs several religious functions. Cosmology provides meaning and purpose to life, access to God and divine knowledge, and addresses the creation of the universe. Each function adds to cosmology's importance for society. Again, this gives cosmology socio-religious benefits which provide a social context for Davies' justifications based on the past success of science.

Hawking also focuses on the cosmological quest for a theory of everything. However, Hawking believes the quest for a final theory is hard to justify on practical grounds. Instead, he provides the following argument:

> Because the partial theories that we already have are sufficient to make accurate predictions in all but the most extreme situations, the search for the ultimate theory of the universe seems difficult to justify on practical grounds. (It is worth noting, though, that similar arguments could have been used against both relativity and quantum mechanics, and these

> theories have given us both nuclear energy and the microelectronics revolution!) The discovery of a complete unified theory, therefore, may not aid in the survival of our species. It may not even affect our life-style. But ever since the dawn of civilization, people have not been content to see events as unconnected and inexplicable. They have craved an understanding of the underlying order in the world. Today we still yearn to know why we are here and where we came from. Humanity's deepest desire for knowledge is justification enough for our continuing quest. And our goal is nothing less than a complete description of the universe we live in.
>
> (BHT: 13)

Hawking seems to rely on a "knowledge for knowledge's sake" justification of cosmology by appealing to Humanity's curiosity and desire for knowledge. Hawking parallels Davies by justifying the quest to understand the universe and our existence and implying that a final theory will answer questions addressing "why we are here and where we came from." In other words, cosmology will explain the meaning of life. In other passages, Hawking expresses his belief that cosmology will achieve a final theory, possibly in our lifetime (BHT: 156, 167). Finally, Hawking ends his text with the hope a final theory may enable us to know the mind of God (see (BHT: 175) on p. 28). Here, Hawking brings his justification of the quest together with the scientific-religious imagery presented in the text. Cosmology provides meaning and purpose to our lives and knowledge of God -- the social payoffs of continuing the quest. In addition, these arguments appear in chapters (Chapters 1, 10, 11) with high rates of scientific-religious imagery (see Appendix B) which strengthens the association between the justificatory arguments and scientific-religious images. Through this association, then, the scientific-religious imagery provides a social context for Hawking's arguments.

Finally, Barrow does not justify cosmology by citing social benefits or claiming that science's past success warrants future support. Instead, like several of the authors, Barrow discusses the relationship between astronomy, HEP, and the early universe:

> These two frontiers of our understanding -- the small world of elementary parts of matter and the astronomical world of the stars and galaxies --

> have come together in unexpected ways in recent times. Where once they were the domains of different groups of scientists attempting to answer quite different questions by separate means, now their interests and methods are intimately entwined. The secret of how galaxies came into being may well be fathomed by the study of the most elementary particles of matter in the particle detectors buried deep underground; the identity of those elementary particles may be revealed by observations of distant starlight. And as we try to reconstruct the history of the universe, searching for the fossil remnants of its youth and adolescence, we find that by the coming together of the largest and the smallest aspects of the physical world our appreciation of the unity of the universe becomes more impressive and complete.
>
> (OU: xiv)

Barrow presents cosmology as progressing to an understanding of the universe through the convergence of HEP and astronomy. So, instead of arguing for the SSC, Barrow uses the HEP connection to present an image of cosmology as advancing towards the "secrets" of the universe. As a result, when he writes about cosmology in terms of Laws-*of*-God and presents cosmological theories as creation myths, he offers cosmology as providing knowledge of God and our place in the universe (OU: xii, 27) (see (OU: xii) on pp. 46-47). In other words, cosmology gets closer to answering the ultimate questions. This justifies cosmology and its continued support by adding social benefits to cosmology, even though Barrow does not argue or appeal for society's backing.

The scientific-religious imagery provides a socio-religious context to the authors' justificatory arguments. By giving cosmology and cosmologists religious roles, the imagery presents cosmology as providing these social benefits. As a result, cosmology becomes more important to society, which helps justify cosmology's continued support. All of the texts attempt to justify cosmology, and some of the authors directly appeal to society for continued support. Although the arguments vary in scope, we see some common themes. The texts stress HEP's role in cosmology, especially in arguments for the SSC. Historical arguments based on the past success and socio-economic benefits of cosmology also appear. Now, these justificatory arguments focus on the same themes as the scientific-religious imagery (e.g., the cosmological quest, a final

theory, the God particle) and appear in areas of the texts with high concentrations of scientific-religious imagery. As a result, the texts associate their justifications of cosmology with the scientific-religious imagery's appropriation of religious functions. Through this link, the model of Cosmology-as-Religion provides a socio-religious context to the justificatory arguments. For Weinberg and Lederman, these appropriated functions add to cosmology's social benefits. With the other authors, the religious functions provide *the* social context. As a result, the scientific-religious imagery strengthens the authors' justifications by increasing the social value of cosmology. In this way, then, the appropriation of religious authority helps legitimate the justification of cosmology.

CHAPTER 5: Conclusion

The primary texts present cosmology with religious language, metaphors, and images, as well as theological concepts. As a result, they create scientific-religious imagery which gives cosmology and cosmologists religious functions. Taking these images together, the texts present a model in which cosmology performs like a religion. In other words, the texts present the model of Cosmology-as-Religion. Thus, the religious appeals appropriate religious authority. However, the texts also contain arguments for the significance of cosmology and the importance of continuing the cosmological quest. These justificatory arguments incorporate the themes of the scientific-religious imagery (e.g., the cosmological quest, a final theory, the God particle). In addition, the arguments appear in sections of the texts with high concentrations of scientific-religious imagery. Because of this, the texts link the justificatory arguments to the religious appeals. This associates the texts' appropriation of religious authority with the justificatory arguments. As a result, the appropriated functions give cosmology additional social benefits. This, in turn, increases cosmology's importance to society.

We found that the texts present multiple images of the laws of physics and God. In the Laws-*of*-God metaphor, the laws *represent* God's design or plan. To create Laws-*of*-God, some passages explicitly state that God or another transcendent agency established the laws, while others imply the laws come from God through the use of passive voice (e.g., the laws have been written or built into nature). As a result, cosmology learns about God by discovering the laws God created. In addition, this places cosmologists in the role of priests, both learning about God and interpreting God's design or message through the laws of physics. Representing God's message, the laws function as Scripture. The texts also present the laws as *restricting* and *replacing* God. With the Laws-*on*-God image, the laws restrict God's actions, and they become the ultimate authority over the creation and governance of the universe. For Laws-*as*-God, the laws replace God in these roles. In the Laws-*on/as*-God images, the texts give the laws of physics God-like abilities over the creation and evolution of life and the universe. In addition, laws acquire other God-like qualities, transcending the physical universe. With the move from representation to restriction or

replacement, the role of the cosmologists shifts as well. We saw that Laws-*as*-God implies a more intimate relationship between the cosmologists and God. They have direct contact with God as the laws of physics, and they deliver God's message via scientific knowledge to society at large. In a sense, the cosmologists speak for God, writing Scripture instead of just interpreting it. Likewise, with the Laws-*on*-God image, cosmologists bypass God and provide knowledge about a higher agency or authority. In all three images of the laws and God, cosmologists function as priests -- an image the texts develop further.

The Cosmologists-as-Priests metaphor operates on two levels. First, as a scientific clergy, cosmologists belong to a special group that has access to God and divine knowledge. Second, cosmology becomes a religious or spiritual endeavor, making cosmologists spiritual leaders. We saw that the image that cosmologists can know the mind of God reinforces Laws-*as*-God and gives cosmologists access to divine knowledge. In addition, instruments function as religious objects which facilitate the pursuit of this knowledge. Big machines, like accelerators and satellites, also serve as gathering places for cosmologists. Around these machines, the faithful come together to worship and study God. As a result, cosmologists acquire knowledge of God through experimental research conducted with instruments and machines. The texts also present cosmology as a mystical calling in which research becomes a spiritual journey, meditation, or act of worship. Through research, cosmologists gain spiritual satisfaction, mystical insights, and revelation. Looking again at instrumentation, research serves as a set of ritualistic practices or acts of worship centered on the instruments and machines. Further, according to the Cosmologists-as-Martyrs metaphor, cosmologists endure hardships and suffering in their practice. In other words, the texts present research as a spiritual and religious quest. As a result, through the laws of physics, research, and instrumentation, cosmologists experience the mind of God. They acquire divine knowledge and impart it to society, functioning as a scientific clergy -- a privileged group of holy men and women who have access to God and divine knowledge.

In addition, the texts present cosmology as providing meaning and purpose to life, and we found that the texts accomplish this in two ways. First, according to the texts, cosmology defines a place for humans in the universe, revealing

that our existence serves a purpose and, as a result, has meaning. Here, the authors claim that human existence, or any intelligent life, fits into the underlying order or organization of the universe. In this sense, the texts define a role or place for humans in the world. In addition, the texts compare big bang theory to religious creation myths, claiming both provide meaning and purpose to our lives. Thus, cosmology answers, or offers the possibility of answering, the questions of 'why are we here? and 'what is the meaning of life.' The texts give cosmology the role of defining a purpose to our existence and offering meaning to our lives -- functions often performed by religion.

Finally, the texts compare cosmology and religion through the positioning of scientific and theological ideas. In some cases, the texts present a historical progression that starts with a theological concept and ends with a contemporary version of that theory in cosmology. Through this progression, the texts present cosmology as superseding religion. In other cases, the texts simply compare cosmological theories to theological concepts. Both assert cosmology's ability to addresses theological issues. Cosmology either addresses or takes over theological issues, especially concerning the creation of the universe. As a result, positioning gives cosmology another religious function -- the study of theological issues.

This scientific-religious imagery converges on a single theme: the model of Cosmology-as-Religion. Since the imagery gives cosmology and cosmologists religious roles, the texts present a model of cosmology that functions like a religion. In addition, this model contains many elements of conventional religion -- conceptual and structural. Conceptually, Cosmology-as-Religion includes scripture, priests, and creation myths. The model also contains an infrastructure: instrumentation serves as objects of worship; large machines function as gathering places or churches; and research performs as a set of ritualistic practices. Finally, through Laws-*on/as*-God restricting or replacing God and the use of positioning tactics, the texts assert science's superiority over religion. Thus, the texts create an image of cosmology superseding religion, reinforcing cosmology's assumption of religious functions.

The texts also contain non-religious imagery. However, a qualitative difference exists between the scientific-religious and non-religious imagery. The

majority of the non-religious imagery consists of various themes and does not fit into a consistent model. For example, some of the texts present a detective story metaphor in which cosmology uncovers the mysteries of the universe. However, this image remains confined to minor portions of the texts and is not developed into a comprehensive model of cosmology. On the other hand, the scientific-religious imagery forms a coherent, dominant model which appropriates religious functions. We also find aesthetic imagery in the texts. Here, the authors discuss nature and the laws of physics in terms of aesthetic qualities like beauty, simplicity, and symmetry. Generally, the scientific-religious imagery incorporates the texts' use of aesthetics. As a result, the aesthetic imagery complements the model of Cosmology-as-Religion. Weinberg develops the aesthetics imagery more than the other authors, and it represents a significant theme in his text. However, Weinberg's aesthetic imagery does not contradict the scientific-religious imagery. In addition, even though Weinberg argues against using 'God' metaphors when discussing cosmology and believes cosmology cannot perform certain religious functions, his text still creates scientific-religious imagery that gives cosmology religious roles. As a result, the non-religious imagery does not interfere with my arguments concerning the role of the scientific-religious imagery in creating Cosmology-as-Religion and appropriating religious authority.

Scholarship in science and technology studies, especially the work of Evelyn Fox Keller, helps illuminate how the religious appeals appropriate religious authority. Similar to the male appropriation of female procreativity discussed by Keller (Keller, 1990a), cosmology appropriates religious functions through the scientific-religious imagery in the texts. To create this imagery, the texts both adopt the language of religion and compare cosmology to religion. This parallels the appropriation of scientific authority by scientific creationists described by Christopher P. Toumey (Toumey, 1991). However, in the case of the primary texts, the appropriation goes in the opposite direction -- from religion to science. In addition, we found concentrations of scientific-religious imagery around the appropriation of religious functions. This helps make the appropriation of religious authority in the texts successful. Thus, the scientific-religious imagery appropriates religious authority, legitimating cosmology's attempt to gain access

to areas of knowledge traditionally controlled by religion. As a result, through the model of Cosmology-as-Religion, cosmology can address the secrets of the universe, our existence, and God.

Now, the significance of the appropriation of religious authority lies in its relationship to the texts' justificatory arguments. All of the primary sources, in one way or another, justify cosmology, but they differ in the scope and directness of their arguments. Some of the authors appeal directly for continued support, while others use more implicit arguments. Despite this, we saw several common themes. The texts stress the significance of HEP to the early universe and big bang theory. With Weinberg, Lederman, and Smoot, this increases the importance of the SSC and helps to justify its construction. In addition, historical and socio-economic arguments call for continued support based on cosmology's past success and technological, social, and economic benefits. These justificatory arguments focus on the quest for a final theory, answers to the ultimate questions (e.g., why does life and the universe exist?), the God particle and the SSC, etc. -- the same subjects around which the authors build the scientific-religious imagery. In addition, the arguments tend to appear in passages with high concentrations of scientific-religious imagery. Because of this, the texts associate the justificatory arguments with the scientific-religious imagery which provides a socio-*religious* context to the arguments. By giving cosmology and cosmologists religious roles, the imagery gives cosmology these socio-religious benefits. As a result, cosmology becomes more important to society, which helps justify cosmology's continued support. Thus, the model of Cosmology-as-Religion provides a socio-religious context which strengthens the authors' justificatory arguments. In this way, then, the religious appeals help legitimate the justification of cosmology.

APPENDIX A: Lederman's Very New Testament

The Genesis passage and the Very New Testament in Lederman's text follow.

And the whole earth was of one language, and of one speech.

And it came to pass, as they journeyed from the east, that they found a plain in the land of Shinar; and they dwelt there. And they said one to another, Go to, let us make brick, and burn them thoroughly. And they had brick for stone, and slime had they for mortar. And they said, Go to, let us build us a city and a tower, whose top may reach unto heaven; and let us make us a name, lest we be scattered abroad upon the face of the whole earth.

And the Lord came down to see the city and the tower, which the children of men builded. And the lord said, Behold, the people *is* one, and they have all one language; and this they begin to do: and now nothing will be restrained from them, which they have imagined to do. Go to, let us go down, and there confound their language, that they may not understand one another's speech.

So the Lord scattered them abroad from thence upon the face of all the earth: and they left off to build the city. Therefore is the name of it called Babel.

-- Genesis 11:1-9

(GP: 23)

And the whole universe was of many languages, and of many speeches.

And it came to pass, as they journeyed from the east, that they found a plain in the land of Waxahachie, and they dwelt there. And they said to one another, Go to, let us build a Giant Collider, whose collisions may reach back to the beginning of time. And they had superconducting magnets for bending, and protons had they for smashing.

And the Lord came down to see the accelerator, which the children of men builded. And the Lord said, Behold the people are unconfounding my confounding. And the Lord sighed and said, Go to, let us go down, and there give them the God Particle so that they may see how beautiful is the universe I have made.

-- The Very New Testament, 11:1

(GP: 24)

And the Lord looked upon Her world, and She marveled at its beauty -- for so much beauty there was that She wept. It was a world of one kind of particle and one force carried by one messenger who was, with divine simplicity, also the one particle.

And the Lord looked upon the world She had created and She saw that it was also boring. So She computed and She smiled and She caused Her Universe to expand and to cool. And lo, it became cool enough to activate Her tried and true agent, the Higgs field, which before the cooling could not bear the incredible heat of creation. And in the influence of Higgs, the particles suckled energy from the field and absorbed this energy and grew massive. Each grew in its own way, but not all the same. Some grew incredibly massive, some only a little, and some not at all. And whereas before there was only one particle, now there were twelve, and whereas before the messenger and the particle were the same, now they were different, and whereas before there was only one force carrier and one force, now there were twelve carriers and four forces, and whereas before there was an endless, meaningless beauty, now there were Democrats and Republicans.

And the Lord looked upon the world She had created and She was convulsed with wholly uncontrolled laughter. And She summoned Higgs and , suppressing Her mirth, She dealt with him sternly and said:

"Wherefore hast thou destroyed the symmetry of the world?"

And Higgs, shattered by the faintest suggestion of disapproval, defended thusly:

"Oh, Boss, I have not destroyed the symmetry. I have merely caused it to be hidden by the artifice of energy consumption. And in so doing I have indeed made it a complicated world.

"Who could have foreseen that out of this dreary set of identical objects, we could have nuclei and atoms and molecules and planets and stars?

"Who could have predicted the sunsets and the oceans and the organic ooze formed by all those awful molecules agitated by lightening and heat? And who could have expected evolution and those physicists poking and probing and seeking to find out what I have, in Your service, so carefully hidden?"

And the Lord, hard put to stop Her laughter, signed forgiveness and a nice raise for Higgs.

-- The Very New Testament 3:1

(GP: 342-343)

APPENDIX B: Page Counts of Scientific-Religious Imagery

The tables below represent page counts of instances of the theological concepts and religious language, metaphors, and images that create the scientific-religious imagery in the primary texts. I will refer to these instances as "SRI" (for scientific-religious imagery/images). The "Average SRI" represents the frequency of SRI occurring in each chapter, and is given in SRI per 10 pages (e.g., 4 SRI's over a 20 page chapter equals an average of 2 SRI's per 10 pages). Numbers in parentheses are adjusted for various reasons explained in the discussions of the tables. The "Average SRI" numbers include the "Positioning" numbers.

The SRI numbers include occurrences of images related to Cosmology-as-Religion and the assumption of religious functions (e.g., Laws-*as*-God, Cosmologists-as-Priests, passages offering meaning and purpose) . If a paragraph or sentence presents one idea that overlaps into several images, I counted it as one SRI. For example:

> As I have explained at length, creation cannot consist of merely causing the big bang. We are searching instead for a more subtle, timeless notion of creation which, to use Hawking's phrase, breathes fire into the equations, and thus promotes the merely possible to the actual existing. This agency is creative in the sense of being somehow responsible for the laws of physics, which govern, among other things, how space-time evolves.
>
> Naturally the theologians argue that the creative agency that provides an explanation for the universe is God. But what sort of agency would such a being be?
>
> (MG: 171)

Here, Davies presents the Laws-*of*-God image (the God-like agency is responsible for the laws) which also places cosmologists in the role of priests, learning about this agency. This passage, however, contains one theme -- Davies' creative agency. If a section contains two or more distinct images, each distinct image counts as an SRI. Above, if Davies referred to the creative agency and then compared cosmologists to priests, then his passage would have counted as two SRI. For example:

> The Catholic Church had made a bad mistake with Galileo when it tried to lay down the law on a question of science, declaring that the sun went round the earth. Now, centuries later, it had decided to invite a number of experts to advise it on cosmology. At the end of the conference the participants were granted an audience with the pope. He told us that it was all right to study the evolution of the universe after the big bang, but we should not inquire into the big bang itself because that was the moment of Creation and therefore the work of God. I was glad then that he did not know the subject of the talk I had just given at the conference -- the possibility that space-time was finite but had no boundary, which means that it had no beginning, no moment of Creation. I had no desire to share the fate of Galileo, with whom I feel a strong sense of identity, partly because of the coincidence of having been born exactly 300 years after his death!
>
> (BHT: 116)

Hawking does two things. First, he presents the martyr image (he mentions Galileo at the beginning and end of the paragraph, but it counts as one theme and, therefore, one SRI). Second, Hawking presents the image that cosmologists learn about God since his talk concerned the moment of creation -- "the work of God." As a result, this passage counts as two SRI.

For the "Positioning" counts, every concept counted as an instance of positioning (see pp. 45-47). For example, if a section mentions creation *ex nihilo* (i.e., creation out of nothing) and St. Augustine's concept of time in relation to quantum cosmology, I counted each concept -- two instances for this example. In addition, if one of those concepts appears later in the chapter, referring back to the original presentation of that concept, I counted each reference as one instance of positioning. Thus, if an author mentions creation *ex nihilo* three more times in the chapter, that counts as three more SRI.

Barrow: *The Origin of the Universe*

	Average SRI* (per 10 pp.)	Positioning (per 10 pp.)
Preface	2.0	2.0
Chapter 1	0.6	0
Chapter 2	2.9/(6.7)	1.2/(3.3)
Chapter 3	1.8	0.6
Chapter 4	0.5	0
Chapter 5	1.2	0
Chapter 6	2.9/(12)	1.0/(4.0)
Chapter 7	2.9/(6.0)	0
Chapter 8	1.1	0

* Average SRI includes Positioning figures

The large number for the Preface reflects a comparison of "ancient" and modern creation stories (OU: xii). Since the Preface is only 5 pages, the total SRI/10 pp. equals 2.0. However, the numbers in parentheses for Chapters 2, 6, and 7 represent concentrated areas of SRI. Four out of five SRI's in Chapter 2 occur in a discussion of the fate of the universe (i.e., whether the universe will expand forever or eventually contract to a "big crunch") (OU: 24-29). Here, Barrow discusses cosmology's influence on theology, compares cosmology to ancient myths, and presents the Laws-*as*-God metaphor. In Chapter 6, all of the SRI take place in the last five pages discussing quantum cosmology and the creation of the universe (OU: 109-113). In this section, Barrow uses positioning techniques (see pp. 45-47) regarding creation out of nothing, and he presents Laws-*as*-God. Finally, the Chapter 7 SRI concentrates around questions of our existence with three out of four SRI's in the last five pages (OU: 124-128). Here, Barrow offers a purpose for our existence. The chapters discussing the history

of cosmology and explaining theoretical concepts (Chapters 1, 4, 5) tend to have low SRI counts.

Davies: *The Mind of God*

	Average SRI* (per 10 pp.)	Positioning (per 10 pp.)
Preface	12	0
Chapter 1	3.0	0.5
Chapter 2	4.4	1.8
Chapter 3	6.5	0.5
Chapter 4	1.3	0.4
Chapter 5	1.7	0
Chapter 6	2.9	0
Chapter 7	6.4	2.1
Chapter 8	3.8	0.7
Chapter 9	5.0	1.0

* Average SRI includes Positioning figures

Generally, *The Mind of God* contains large SRI numbers. The short Preface contains an extremely high frequency of SRI. In five pages, Davies both argues that science supersedes religion, and justifies cosmology based on the past success of the scientific method (MG: 13-14); claims science led him to believe in a God-like "deeper level of explanation" (MG: 16); and offers cosmology as providing meaning and purpose to life and the universe (MG: 16). As a result, Davies gives cosmology the religious functions of providing divine knowledge about the creation of the universe and offering a purpose to our existence. On the other hand, Chapter 1 also contains a justificatory argument and a passage offering meaning and purpose, but the chapter only has an average SRI count (average for Davies -- the 3.0 figure is fairly high compared to the other authors) (MG: 20-21). The large number of SRI's for Chapter 3, "What are the Laws of Nature," consist predominantly (about 75%) of Laws-*of/as*-God. Chapters 2 and

7 discuss the creation of the universe and contain high counts of both SRI and positioning moves. The positioning places cosmology above religion, assuming authority over knowledge of the creation of the universe. Chapter 8, on the other hand, discusses the design of the universe, addressing the question: what can science tell us about God? Here, we only see an average number of SRI's (again, average for Davies -- 3.8 equals a high occurrence of SRI). Chapter 9 concludes the text with a high number of SRI's. As with the Preface, Davies presents cosmology as offering meaning and purpose (MG: 232). In addition, this chapter presents a strong Cosmologists-as-Priests image (MG: 223, 227-228).

The three middle chapters (Chapters 4, 5, 6) discuss mathematics and have relatively low SRI counts. Chapter 6, however, contains several images of mathematics of/as God which tie into the imagery of laws and God (since the laws of physics are mathematical). This explains Chapter 6's higher SRI numbers.

Hawking: *A Brief History of Time*

	Average SRI* (per 10 pp.)	Positioning (per 10 pp.)
Chapter 1	3.1/(5.0)	1.5/(2.5)
Chapter 2	0.5	0
Chapter 3	0.6	0
Chapter 4	4.4	0
Chapter 5	0	0
Chapter 6	1.2	0
Chapter 7	0	0
Chapter 8	2.6	0
Chapter 9	0.9	0
Chapter 10	3.3/(13)	0.7/(2.5)
Chapter 11	10	0

* Average SRI includes Positioning figures

Hawking's SRI focuses on two themes: the creation of the universe and a TOE (theory of everything). Chapter 1 includes a section on the history of science that does not contain any SRI. Subtracting the history section produces the adjusted numbers in parentheses. In this chapter, Hawking uses positioning tactics and Laws-*on/as*-God to present cosmology as superseding religion (i.e., cosmology taking over the roles of providing knowledge of God or some other supreme agency and knowledge of the creation of the universe), concluding with an argument justifying cosmology and its quest for a theory of everything. In Chapter 10, "The Unification of Physics," we also see relatively large numbers of SRI's concerning the theory of everything, including a "complete understanding" of our existence (BHT: 169). In fact, all of the SRI occurs in the last four pages;

the adjusted numbers reflect the concentration of SRI in these pages (the beginning of the chapter explains string theory). Chapter 8 discusses the origin and fate of the universe and contains a large number of SRI. Here, Hawking presents cosmology as a means to knowledge of God (BHT: 122-123, 125, 127, 136, 140-141). Finally, Hawking ties these themes together in Chapter 11. In this chapter, Hawking again presents Laws-*on/as*-God taking over the role of the Creator, and he concludes with his "mind of God" passage, linking the TOE to the mind of God (BHT: 175).

The two chapters (Chapters 2, 3) on the history of science have low SRI counts. The highly theoretical chapters (Chapters 5, 6, 7, 9) concerned with explaining physics (e.g., black holes, time, HEP) also contain low SRI numbers. However, Chapter 4 represents an exception. This chapter discusses the history of quantum mechanics and includes a few references to God and one Laws-*as*-God image (BHT: 54, 55, 56).

Lederman: *The God Particle*

	Average SRI* (per 10 pp.)	Positioning (per 10 pp.)
Chapter 1	4.6	0
Chapter 2	1.5/(8.0)	0
Interlude A	0	0
Chapter 3	2.8	0.3
Chapter 4	0	0
Chapter 5	1.0	0
Interlude B	1.0	0
Chapter 6	0.7/(6.7)	0
Interlude C	2.2	0
Chapter 7	0.4	0
Chapter 8	2.3	0
Chapter 9	3.8	0

* Average SRI includes Positioning figures

Lederman's first chapter and last two chapters contain relatively high SRI counts. Chapter 1 contains the highest concentration of SRI per chapter. In this chapter, Lederman presents the metaphors Laws-*of/as*-God, cosmological theories as myth, and Cosmologists-as-Priests/Martyrs (GP: 1, 18; 2, 22; 6, 16); offers a purpose to our lives (GP: 3); and concludes the chapter with the Very New Testament justifying the SSC as a means to know the mind of God (GP: 24). Chapter 8's discussion of contemporary HEP (e.g., recent discoveries and theoretical developments, unsolved problems) and the God particle includes, as an epigraph, another passage of the Very New Testament (GP: 342-343). This chapter also has a high frequency of SRI which presents cosmology as a means

to divine knowledge and God, keeping in theme with the Very New Testament passage at the end of Chapter 1. Finally, in Chapter 9, Lederman discusses HEP and astronomy (including the God particle's role in the inflation model of the big bang), final theories, and COBE. Again, the SRI focuses on cosmology as a path to God, including references to the Tower of Babel and the SSC obtaining knowledge of God through the God particle (GP: 400, 407). This chapter also includes Laws-*as*-God, Cosmologists-as-Priests, and an appeal for support to continue the quest (GP: 401, 402; 400-401; 408). Most of the SRI in this chapter also build on the Very New Testament theme: in general, cosmology provides knowledge of God, and specifically, the SSC will reveal divine knowledge by discovering the God particle.

The chapters discussing the history of science have low SRI counts except for Chapter 3. Most of the SRI in Chapter 2 occurs in the first five pages discussing Fermilab and accelerators (four out of six SRI's); the number in parentheses reflects the SRI concentration of this section. The rest of the chapter discusses the history of Greek science with infrequent SRI. Chapters 4 and 5 also discuss the history of science and have low SRI numbers; Chapter 4 describes developments in electricity and chemistry leading up to quantum mechanics, discussed in Chapter 5. In these sections, other imagery (e.g., music metaphors, the detective story, and Santa (GP: 109, 127; 143, 146, 149, 151; 183)) equals or outnumbers the SRI. Chapter 3 discusses the history of science, but contains a high frequency of SRI. This chapter discusses the rise of "modern" physics in the 17th century and includes Galileo, Kepler, Brahe, and Newton. This section contains many images of cosmologists as priests and martyrs, particularly in the cases of Galileo (martyr) and Newton (spiritual leader or priest).

Moving to chapters explaining theoretical and experimental physics, Chapter 7 explains the fundamental particles and forces of HEP's Standard Model, containing SRI in comparable numbers to other imagery (e.g., Santa, music metaphors (GP: 282, 330)). Chapter 6 discusses the development of accelerators and explains how these machines work. This chapter also contains relatively low SRI numbers. However, the SRI presents accelerators as religious objects enabling cosmologists to obtain knowledge of God. In addition, the last

few pages contain half of the chapter's SRI (two out of four) and includes the time machine and cathedral metaphors. The number in parentheses represents the SRI concentration over the last few pages of Chapter 6.

Interlude A consists of a one page diagram that does not contain any SRI. In Interlude B, "The Dancing Moo-Shu Masters," Lederman critiques books comparing modern physics to Eastern religion and mysticism. Lederman specifically criticizes Fritjof Capra's *The Tao of Physics* and Gary Zukav's *The Dancing Wu Li Masters*. The interlude concludes with Lederman's philosophy of scientific progress. Neither of these sections contain large numbers of SRI. Finally, Lederman gives an account of an experiment which discovered parity violation in Interlude C. This description includes SRI suggesting that cosmologists discover divine knowledge.

Thus, most of the high SRI numbers outside of Chapters 1, 8, and 9 focus on accelerators as religious objects and places, enabling physicists to acquire divine knowledge. In other words, the high concentrations of SRI focus on cosmology providing knowledge of God. Chapter 3, on the other hand, seems to treat the founders of modern physics (as Lederman presents them) as Church fathers, presenting Galileo and Newton as holy men.

Smoot: *Wrinkles in Time*

	Average SRI* (per 10 pp.)	Positioning (per 10 pp.)
Preface	0	0
Chapter 1	3.9/(5.0)	1.1/(1.4)
Chapter 2	2.6	0.9
Chapter 3	0.8	0
Chapter 4	1.9	0.5
Chapter 5	1.5	0
Chapter 6	0.5	0.5
Chapter 7	1.0	0
Chapter 8	0	0
Chapter 9	1.1	0
Chapter 10	0.5	0
Chapter 11	1.2	0
Chapter 12	0	0
Chapter 13	1.5	0
Chapter 14	3.8	0.4

* Average SRI includes Positioning figures

The SRI increases in the first and last chapters. Further, the numbers in parentheses for Chapter 1 are adjusted to account for four pages of diagrams (i.e., the four pages are subtracted from the total number of pages to calculate the adjusted figures). The higher frequency of imagery in Chapters 1 and 14 coincides with Smoot's discussion of the cosmological quest and the ultimate questions. Both chapters contain the passages in which cosmology offers

meaning and purpose to our lives. Cosmology provides meaning and purpose through creation myths (i.e., big bang theory) (WT: 17-18, 297) and by defining a role for humans in the universe (WT: 290, 296-297). Further, Chapter 14 contains Smoot's appeal to society for continued support of cosmology, including satellite missions like COBE and the SSC (WT: 295). The other chapters with lower numbers of SRI mostly discuss the history of cosmology (Chapters 2, 3, 4); theoretical explanations of physics (Chapters 5, 8, 9); and descriptions of experiments, including personal accounts of COBE and the South Pole experiments (Chapters 6, 7, 10, 11, 12, 13).

Weinberg: ***Dreams of a Final Theory***

	Average SRI* (per 10 pp.)	Positioning (per 10 pp.)
Preface	0	0
Chapter 1	1.9	0
Chapter 2	1.3	0
Chapter 3	0	0
Chapter 4	0.8	0
Chapter 5	0	0
Chapter 6	1.8	0
Chapter 7	0.4	0.4
Chapter 8	0	0
Chapter 9	3.2	0
Chapter 10	0	0
Chapter 11	5.2/(3.8)	0
Chapter 12	0	0
Afterword	0	0

* Average SRI includes Positioning figures

The high occurrence of SRI takes place in chapters 9 and 11. Chapter 9 discusses the final theory, including string theory as a possible final theory and what a final theory needs to explain. Here, the majority of the SRI presents Laws-*as*-God (five out of six). In Chapter 11, Weinberg discusses the final theory and God. Three of the SRI's, however, need qualifications. Weinberg makes two statements that the final theory, if anything, would tell us something about God, but Weinberg then asserts that he does not believe the final theory

will in fact do this (DFT: 242, 250, 251). In addition, Weinberg notes that some of his colleagues get spiritual satisfaction from science equivalent to a belief in God. Again, Weinberg states he does not feel this way (see pp. 56-59). Even if we remove these three SRI's (producing the adjusted number in parentheses), the SRI rate remains the largest of the text. The rest of the SRI's in Chapter 11 (seven out of eight) present cosmology as superseding religion. These SRI's consist of three Laws-*as*-God and four arguments stating science's superiority over religion (DFT: 242, 245, 248; 249, 254-255, 258-259). Thus, the high concentrations of SRI focus on the final theory and cosmology superseding God and religion.

Several other chapters show average SRI numbers. In all the chapters, Laws-*as*-God represents the dominant image. Chapter 1 addresses the laws of nature and a final theory. Here, Weinberg presents two instances of the Laws-*as*-God metaphor and one instance of the Cosmologists-as-Priests metaphor (DFT: 9, 10; 17-18). Weinberg presents his idea of converging arrows of explanation in Chapter 2. Here, three out of four SRI's deal with Laws-*as*-God (DFT: 33, 46-47, 48). Finally, in Chapter 6, "Beautiful Theories," Weinberg discusses the aesthetic qualities of theories. Out of six SRI's, five present Laws-*as*-God (DFT: 138, 142, 146, 147, 151-152).

Weinberg's arguments justifying cosmology and the SSC appear most often in Chapters 3, 8, 10, and 12 as well as the Afterword. These chapters contain *no* SRI. They discuss the final theory and the SSC without religious appeals.

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