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# SAGAN'S COSMOS: SCIENCE EDUCATION OR RELIGIOUS THEATER?

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**B**ILLIONS AND BILLIONS OF STARS IN EACH OF BILLIONS and billions of galaxies. In 1980 Cornell astronomer Carl Sagan gave to the number *billion* (initiated with an exploding *b*) a heightened level of familiarity among the viewers of his public television series, "Cosmos."

Captivated by breath-taking cosmic vistas, soul-stirring background music and mind-boggling data from the natural sciences, an estimated ten million viewers joined Sagan on his "personal voyage" through the Cosmos. (Drawing in part on the ancient Greek concept of a harmoniously regulated, and therefore intelligible, world, Sagan persistently employed the term *Cosmos* as the proper name for the physical universe that is the object of scientific scrutiny and the focus of Sagan's concern.) Viewers were informed of the varied contents and

vast dimensions of the universe; and they were shown the contemporary picture of cosmic history—a history beginning with the Big Bang and progressively unfolding with the appearance of galaxies, stars, planets, living things and, finally, a species characterized by Sagan as self-conscious molecular machines capable of pondering the vast Cosmos from which they arose. This is the species of persons who now ask, Where are we? and, far more profoundly, Who are we?

"Cosmos" was well grounded in the results of scientific investigation. Sagan has excellent credentials as a knowledgeable practicing scientist, and he draws deeply from the well of contemporary scientific theory and from the pool of observational data. Viewers could rest assured that the science component of "Cosmos" was representative of what the professional scientific community has come to know about the physical universe in which we live. Furthermore, with a multimillion-dollar budget and a large and skilled production staff, Sagan was able to present the products of scientific investigation in a strikingly vivid and colorful manner. "Cosmos" was able to attract and hold the attention of viewers with a tenacity nearly unrivalled in the public television sector.

There were, of course, some shortcomings. The pace of the presentation varied considerably. At times the flow of technical information was like a rushing stream. Some viewers must have felt as if they were being asked to take a drink from a fire hose. At other times, particularly in some of the historical dramatizations, the stream ran nearly dry.

"Cosmos" also suffered from a very common malady of popularized science: overstating the degree of certainty in many parts of the contemporary scientific picture. In the first episode, Sagan made a significant promise to his viewers. "We will be careful," he said, "to distinguish speculation from fact." And on some occasions such distinctions were made. In the context of a discussion of chemical evolution, Sagan said: "There is still much to be understood about the origin of life, including the origin of the genetic code."<sup>1</sup> But on numerous other

occasions Sagan neglected to remind his viewers of the tentative character of much of today's understanding of cosmic structure, behavior and formative history.

Persons who are thoroughly familiar with the nature of the scientific enterprise need not be repeatedly reminded of the tentativeness that characterizes scientific theorizing, especially on the matter of historical reconstruction, but others—the vast majority, I suggest—need guidance. Educating the nonspecialist on this matter may be difficult, but the general public needs to gain some appreciation for the process of scientific theory evaluation. Judging the merits of a scientific theory must be viewed as the employment of both good common sense and healthy skepticism in an effort to avoid both the propagation of inflexible dogma and the careless expression of groundless opinion.

#### "Cosmos" as Religious Theater

Having called attention to certain educational needs we should now inquire, Was science education the principal goal of "Cosmos"? In my judgment, it was not. Although the results of contemporary science played a prominent role throughout the entire series, I believe that "Cosmos" functioned most powerfully as *religious theater*, that is, as a dramatic presentation of information, concepts and ideas organized around a strongly religious agenda. Furthermore, while recognizing that Sagan deserves considerable credit for providing his audience with a vividly illustrated presentation of the contemporary, scientifically derived picture of the physical universe, I believe that it was the provocative religious agenda and its theatrical format that most captivated the viewing audience.

Such bold statements call for substantiation, so let us briefly consider the religion, the theater and the agenda of Sagan's "Cosmos."

*The religion:* The religious faith that permeated the "Cosmos" series is modern Western naturalism—the perspective formed by the wedding of materialistic monism (there is only one form of reality: matter)

and exclusivist scientism (there is only one way to learn about reality: natural science). Sagan quoted Democritus of Abdera as saying, "Nothing exists but atoms and the void."<sup>2</sup> Standing solidly in the materialist tradition of Democritus, Sagan of Brooklyn opened "Cosmos" with the fundamental tenet of naturalistic religion, "The Cosmos is all that is or ever was or ever will be."<sup>3</sup> The physical universe was asserted to be the only reality; it was assumed that there exists no being or realm that transcends the material world.

As the only reality, the Cosmos must serve to inspire whatever religious stirrings we humans experience. Thus, immediately following the opening statement of the materialist creed, Sagan declared: "Our feeblest contemplations of the Cosmos stir us—there is a tingling in the spine, a catch in the voice, a faint sensation, as if a distant memory, of falling from a height. We know we are approaching the greatest of mysteries."<sup>4</sup>

But what of humanity and human thought? Are these nothing more than instances of complex atomic behavior? Expressing considerable admiration of the insights of Democritus, Sagan wrote, "He taught that perception—the reason, say, I think there is a pen in my hand—was a purely physical and mechanistic process; that thinking and feeling were attributes of matter put together in a sufficiently fine and complex way and not due to some spirit infused into matter by the gods."<sup>5</sup> The perspective on the ultimate character and identity of human beings offered in "Cosmos" is clearly a modernized version of the view of Democritus: we are marvelous molecular machines—somehow deserving of awe, but yet only machines. Said Sagan,

I am a collection of water, calcium and organic molecules called Carl Sagan. You are a collection of almost identical molecules with a different collective label. But is that all? Is there nothing in here but molecules? Some people find this idea somehow demeaning to human dignity. For myself, I find it elevating that our universe permits the evolution of molecular machines as intricate and subtle as we.<sup>6</sup>

Now, if only the physical universe is real, what about the concept of God, or of gods? A candid statement of the materialist faith would be that neither God nor gods exist, period. Discreetly avoiding such a direct expression of atheism, Sagan chose to put this perspective in the form of suggestive questions and of hypothetical statements. For example, after describing the Hindu concept of the universe being the realized form of a divine dream, Sagan suggested, "These great ideas are tempered by another, perhaps still greater. It is said that men may not be the dreams of the gods, but rather that the gods are the dreams of men."<sup>7</sup> Deity, Sagan suggests, is nothing more than a human invention; and human invention, recall, is nothing more than the peculiar output of a complex molecular machine. God is thus reduced to a figment of mechanistic molecular imagination.

Seen as requiring nothing beyond itself as the cause of its existence, or as the governor of its behavior, or as the source of its value and purpose, the Cosmos of the materialist faith must perform many of the functions customarily thought to be dependent on divine action. In that sense the physical universe becomes a material substitute for traditional deities.

Furthermore, the reverence people once directed toward deity, they should now, in the materialist religion, direct toward the Cosmos itself. While in the Judeo-Christian tradition human beings are seen as having their ultimate identity as children of God, "Cosmos" identified the human race entirely in material terms. "We are," said Sagan, "in the most profound sense, children of the Cosmos."<sup>8</sup> And in the video script Sagan professed, "Our ancestors worshiped the Sun, and they were far from foolish. It makes good sense to revere the Sun and the stars because we are their children." Sagan's language may be metaphorical, but the metaphor expresses a creedal tenet. God and Cosmos are no longer distinct; one has been absorbed into the other.

Now, if the physical world were all there is, then it would be easy to conclude that science is the principal, perhaps even exclusive,

means of attaining any knowledge of reality. As we have said already, the natural sciences, when operating within their legitimate domain, provide a powerful means of seeking answers to questions drawn from appropriate categories. Although the sciences cannot deal with *all* questions, they function well in our search for answers to *appropriate* questions (questions regarding the inherent intelligibility of the physical universe). The perspective of science offered in "Cosmos" rightfully called attention to the power of scientific investigation but conspicuously omitted reference to any limitation of domain, asserting instead *unrestricted applicability*. Listen to this litany of praise for the unbounded reach of the scientific approach in the search for understanding our origins:

Its only sacred truth is that there are no sacred truths. All assumptions must be critically examined; arguments from authority are worthless. Whatever is inconsistent with the facts, however fond of it we are, must be discarded or revised. Science is not perfect. It's often misused. It's only a tool. But it's the best tool we have, self-correcting, ever-changing, *applicable to everything*. With this tool we vanquish the impossible.<sup>9</sup>

Elsewhere, in another discussion which failed to distinguish between the question of *origin* and questions about *formative history*, Sagan said:

Every human generation has asked about the origin and fate of the Cosmos. Ours is the first generation [because of its scientific prowess] with a real chance of finding some of the answers. One way or another, we are poised on the edge of forever.<sup>10</sup>

Clearly, then, the "Cosmos" series displayed throughout, from the opening line forward, a specific and powerful religious perspective that functioned as the framework for the interpretation of scientific and historical data. It was the nontheistic religion of modern Western naturalism: the physical world is the ultimate reality, and natural science is the only avenue to understanding. Reality was reduced to matter alone, and a fittingly bounded respect for science was replaced by an unrestrained scientism.

*The theater:* The religious dimension of "Cosmos" was evident not only in its conceptual content but also in its theatrical format. "Cosmos" was powerful theater that effectively maintained an aura of religious awe. The music, for example, functioned with remarkable success to maintain a mood that was haunting, mystical, ethereal, almost worshipful. And Sagan's "ship of the imagination" that carried him on his personal voyage through the Cosmos had the unmistakable appearance of a cathedral, complete with a futuristic variant of Gothic architecture and with a pulpitlike control station well suited for priestly pronouncements.

The format of "Cosmos" bore little resemblance to what would be found in a science classroom. The content of "Cosmos" had considerable educational value, but in genre this television production must be classified as theater—theater with a strongly religious agenda, a subtle but nonetheless effective form of "televangelism."

*The agenda:* Among the many goals which could be identified as comprising the religious agenda of "Cosmos," we will focus here on three that are judged to be especially important.

1. *To imply that a naturalistic religious perspective is warranted by natural science.*

More by persistent implication than by candid statement, "Cosmos" very effectively promoted the idea that a naturalistic *world view* (a perspective on all of reality) is but a simple, logical extension of the scientific *world picture* (a description of the physical universe only). Typical of this approach is the argument that if the physical universe displays an intelligible unity and coherence, then the "god-hypothesis" is unnecessary; and if unnecessary, then to be discarded—surgically removed by Ockham's razor of philosophical economy.\* In a

\**Ockham's razor*, a principle in science and philosophy, states that the number of assumptions employed to explain something should not be multiplied needlessly. This means that the simplest of two or more competing theories is preferable and that an explanation of unknown phenomena should first be attempted in terms of what is already known.

discussion concerning the early Greek discovery of patterned behavior that is accessible to empirical investigation, Sagan performed some of this surgery.

The Babylonian Marduk and the Greek Zeus was each considered master of the sky and king of the gods. You might decide that Marduk and Zeus were really the same. You might also decide, since they had quite different attributes, that one of them was merely invented by the priests. But if one, why not both?

And so it was that the great idea arose, the realization that there might be a way to know the world without the god hypothesis; that there might be principles, forces, laws of nature through which the world could be understood without attributing the fall of every sparrow to a direct intervention of Zeus.<sup>11</sup>

Note carefully the essential element in this argument: If there are intelligible regularities of physical *behavior* that can be discovered by empirical science, then the idea of divine *governance* must be eliminated. Instead of entertaining the idea that divine governance is orderly and noncapricious in character, Sagan chose to eliminate the concept of divine governance entirely. Clearly, that was a religious choice, not a scientific conclusion.

The essential distinction between *behavior* and *governance* appears not to have functioned in this discussion. By failing to give recognition to this distinction, the rhetoric of "Cosmos" strongly implied that the scientific discovery of regular patterns of physical behavior provides sufficient warrant—the crucial proof, if you prefer—for a naturalistic world view. From this it was a relatively short step to the next major item on the religious agenda of "Cosmos":

2. *To assert that this naturalistic religion has triumphed over all forms of theistic religion.*

On numerous occasions "Cosmos" declared the naturalistic perspective to be superior to any form of theism. Naturalism, presumably based solely on the results of empirical science, was alleged to provide superior answers to the same questions as those addressed by theism,

presumably based only on human imagination, superstition and fear. Were this the case, then, naturalism would provide us with keener insights concerning our identity—who we are. Listen to some of the triumphalist rhetoric to be found in "Cosmos":

We are, almost all of us, descended from people who responded to the dangers of existence by inventing stories about unpredictable or disgruntled deities. For a long time the human instinct to understand was thwarted by facile religious explanations.<sup>12</sup>

For thousands of years humans were oppressed—as some of us still are—by the notion that the universe is a marionette whose strings are pulled by a god or gods, unseen and inscrutable.<sup>13</sup>

In a discussion of the rise of systematic science in ancient Greece, Sagan hailed Thales for his attempt to understand the world in wholly naturalistic terms. After describing Thales's theory about the central role played by water, Sagan commented:

Whether Thales's conclusion was correct is not as important as his approach: the material world was not made by the gods, but instead was the work of material forces interacting in Nature.<sup>14</sup>

In a later episode on cosmology "Cosmos" offered still more comparisons of theistic and naturalistic perspectives. One striking and important feature of these comparisons was Sagan's working assumption that scientific cosmology and theological cosmology are concerned with the same questions. This fallacious equating of agendas was necessary, of course, if the scientific picture was to be offered as a superior successor to any theological perspective. As was the case for the behavior/governance distinction, "Cosmos" also failed utterly to recognize the essential distinction between *origin* and *formation*. Following a series of quotations from the creation mythology of various ancient cultures, Sagan asserted that these examples of theological cosmology and the Big Bang model of modern scientific cosmology, though they are quite different in quality, belong in the same category.

These myths are tributes to human audacity. The chief difference

between them and our modern scientific myth of the Big Bang is that science is self-questioning, and that we can perform experiments and observations to test our ideas.<sup>15</sup>

In the video version Sagan said, "The Big Bang is our modern scientific creation myth. It comes from the same human need to solve the cosmological riddle." The fact that theological cosmology and scientific cosmology have remarkably different agendas was completely overlooked in these manifestations of the triumphalist agenda of "Cosmos." In one of his most direct attacks on the theological concept of creation, Sagan once again employed the weapon of Ockham's razor. The Creator's existence was dismissed as an awkward and unnecessary hypothesis that must be cut out in a move toward philosophical frugality.

If the general picture of an expanding universe and a Big Bang is correct, we must then confront still more difficult questions. What were conditions like at the time of the Big Bang? Was there a tiny universe, devoid of all matter and then the matter suddenly created from nothing? How does *that* happen? In many cultures it is customary to answer that God created the universe out of nothing. But this is mere temporizing. If we wish courageously to pursue the question, we must, of course ask next where God comes from. And if we decide this to be unanswerable, why not save a step and decide that the origin of the universe is an unanswerable question? Or, if we say that God has always existed, why not save a step and conclude that the universe has always existed?<sup>16</sup>

Once again the viewer was urged to see naturalism as the triumphant victor over theism. This was by no means a simple lesson in science education. This was powerful religious theater.

But what was the point of this drama? In what way might a naturalistic religion function? Proposing an answer to this question provided yet another major item on the religious agenda of "Cosmos":

3. *To promote the hope that a naturalistic religious perspective will inspire in the human race a loyalty to the Cosmos and a commitment to care for the*

*preservation of both self and environment.*

In a number of places Sagan expressed an admirable concern for conserving natural resources and for maintaining a high-quality environment for human life. Recognizing the cost of putting that concern into action, Sagan said:

Our generation must choose. Which do we value more? Short term profits or the long term habitability of our own planetary home? . . . If a visitor arrived from another world, what account would we give of our stewardship of the planet Earth?<sup>17</sup>

But Sagan's use of terms like *value* and *stewardship* raise some interesting questions. On what basis is *value* determined? To whom are we responsible as *stewards*? A naturalistic religious perspective requires that the answers to these questions be found entirely within the physical universe. Consistent with his dream of a scientifically informed Utopia based solely on a cosmic consciousness, Sagan asserted that, "Humans everywhere share the same goals when the context is large enough. And the study of the Cosmos provides the largest possible context."<sup>18</sup> Having excluded deity from the real world, Sagan must rely on the physical universe as the sole source of significance and as the sole object of one's loyalties. In the closing lines of the series Sagan offered this inward-directed perspective on our identity and our function:

For we are the local embodiment of a Cosmos grown to self-awareness. We have begun to contemplate our origins: starstuff pondering the stars; organized assemblages of ten billion billion billion atoms considering the evolution of atoms; tracing the long journey by which, here at least consciousness arose. Our loyalties are to the species and the planet. *We* speak for Earth. Our obligation to survive is owed not just to ourselves but also to that Cosmos, ancient and vast, from which we spring.<sup>19</sup>

Thus *value* must be expressed in the currency of species preservation and one's *stewardship* must be an expression of loyal obligation to the Cosmos itself.

As a general rule, the attitude expressed in "Cosmos" was one of hopefulness that a wholly naturalistic religion and a loyalty to the universe alone will provide a sufficient basis for a satisfying sense of meaning and significance. But yet within this same work one finds the seeds of insignificance and disillusionment.

That we live in a universe which permits life is remarkable. That we live in one which destroys galaxies and stars and worlds is also remarkable. The universe seems neither benign nor hostile, merely *indifferent* to the concerns of such *puny creatures* as we.<sup>20</sup>

In a number of instances Sagan called us to be loyal and reverent toward the Cosmos. But if that Cosmos is itself both impersonal and indifferent to our human concerns, what satisfaction can possibly be derived from such loyalty? Where the naturalistic religious agenda sought to plant hope we find sprouting the seeds of futility.

### Science Misrepresented

Sagan deserves to be credited, we said, for his knowledgeable and vividly illustrated presentation of the contemporary scientific world picture. Throughout the "Cosmos" series, viewers were provided with very informative descriptions of the contents, structure, behavior and history of the physical universe.

But in spite of our recognition of these praiseworthy features, we would argue that the fundamental character of the scientific enterprise was egregiously misrepresented in "Cosmos." Our principal criticism is that "Cosmos" failed to honor the boundaries of science's limited domain of applicability. What Sagan presented in this work was not merely a *world picture*, but a *world view*—not merely a scientific description of the physical component of reality, but a naturalistic religious perspective on the whole of reality. Furthermore, the naturalistic world view presented in "Cosmos" was treated as if it were but a logical extension of natural science, thus misrepresenting science as if it were capable of providing a sufficient warrant for rejecting any theistic perspective on our existence and our experience.

*Natural science transformed into naturalistic scientism.* When the boundaries of the scientific domain are no longer honored, science is soon transformed into *scientism*. Science is treated as if it were "applicable to everything," to use Sagan's words. The spirit that pervaded "Cosmos" is that our search for answers to questions regarding our identity, our significance, even the source of our existence, are entirely dependent on the natural sciences. The only source of knowledge recognized by "Cosmos" is the physical universe. The only avenue to understanding accepted by "Cosmos" is scientific investigation.

What Sagan failed to point out is that, although natural science chooses to limit the object of its investigation to the physical universe, that does not provide any warrant for asserting that "the Cosmos is all there is or ever was or ever will be."<sup>21</sup> Clearly, such a statement cannot be a conclusion of natural science. Rather, it is the statement of religious faith on which the naturalism of "Cosmos" is founded. Had that distinction between metaphysical assumption and scientific conclusion been candidly made, the religious agenda of "Cosmos" would have been more obvious from the outset.

*Science presented as victor over religion.* Throughout "Cosmos" the warfare metaphor was consistently used to characterize the relationship of science to theistic religion. Ignoring the distinction between *behavior* and *governance*, Sagan treated scientific descriptions of physical behavior as if they were direct competitors to religious concepts of divine governance. Ignoring the distinction between *formation* and *origin*, Sagan treated scientific descriptions of the formative history of the universe as if they were superior replacements for the theistic concept that God is the source for the very existence of the universe.

More could be said to substantiate and reinforce our criticisms of the way in which "Cosmos" caricatured the scientific enterprise, but by this time the point should be clear. By failing to honor the boundaries of the scientific domain, by transforming natural science into naturalistic scientism and by presenting science as the victor over

theism, "Cosmos" misrepresented the character of the scientific enterprise. Although the stage was set for an enriching experience in science education, what actually occurred was religious theater—an evangelistic crusade for modern Western naturalism.

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# EPILOGUE

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## FOLK SCIENCE:

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### THE FACE BEHIND

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### THE MASK

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**W**E ALL HAVE CONCERN FOR MATTERS BEYOND THE limited domain of natural science. Thus we often puzzle about how the results of science may be related to those extrascientific concerns. How, for example, are the results of scientific investigation to be employed as we assemble a comprehensive world view—a perspective in which certain creedal or religious commitments play a prominent role?

In an earlier chapter we strongly discouraged the forced use of natural science to warrant (in the sense of providing a logical or evidential basis for) one's creedal commitments regarding the transcendent realm. We said, for example, that "science held hostage to any ideology or belief system, whether naturalistic or theistic, can no longer function effectively to gain knowledge of the physical universe.



- <sup>13</sup>Henry M. Morris, *The Genesis Record* (San Diego: Creation-Life, 1976).
- <sup>14</sup>Asimov's view of the Bible falls far short of an adequate view of Scripture as the Word of God. "The Biblical writers and editors were thoughtful men who borrowed selectively, choosing what they considered good and rejecting what seemed nonsensical or unedifying. They labored to produce something that was as reasonable and as useful as possible" (p. 3).
- <sup>15</sup>Asimov, *In the Beginning*, p. 11.
- <sup>16</sup>*Ibid.*
- <sup>17</sup>For a satisfying, readable overview of the genuine reactions of scientists in response to the developments of science see, for example, C. A. Russell, *Cross-Currents* (Grand Rapids: Eerdmans, 1985). Many other excellent works on the history of science also make it plain that many outstanding scientists, such as Faraday, Newton, Maxwell, Kelvin and others did not draw the conclusions that Asimov thinks were drawn. Consult, for example, the work of Hooymaas, Klaaren, Raven, Dillenberger and Peacocke. A very readable new work is that of C. E. Hummel, *The Galileo Connection* (Downers Grove, Ill.: InterVarsity Press, 1986).
- <sup>18</sup>Asimov, *In the Beginning*, pp. 11-12.
- <sup>19</sup>We are not here making any judgment about the validity of Futuyma's case for evolution. Futuyma presents the case for evolution cogently and eloquently, but whether or not evolution is "true" is beside the point of the argument that is being made in this case study.
- <sup>20</sup>Futuyma, *Science on Trial*, p. 209.
- <sup>21</sup>*Ibid.*, p. 213.
- <sup>22</sup>*Ibid.*, p. 167.
- <sup>23</sup>*Ibid.*, pp. 169-70.
- <sup>24</sup>*Ibid.*, p. 147.
- <sup>25</sup>*Ibid.*, pp. 12-13.
- <sup>26</sup>*Ibid.*, pp. 98-99.
- <sup>27</sup>Christians, of course, also confess that God placed us on earth to be conscientious stewards of his good creation. Though we may use the earth, we must use it responsibly as those who are image-bearers of the living God and as those who have been entrusted with something that ultimately belongs to the Creator.
- <sup>28</sup>Futuyma, *Science on Trial*, p. 131.

#### Chapter 8: A Masquerade of Science

- <sup>1</sup>P. W. Atkins, *The Creation* (San Francisco: W. H. Freeman & Company, 1981), p. vii.
- <sup>2</sup>*Ibid.*
- <sup>3</sup>*Ibid.*
- <sup>4</sup>Edward R. Harrison, *Cosmology: The Science of the Universe* (Cambridge: Cambridge University Press, 1981), pp. 10-11.
- <sup>5</sup>*Ibid.*, p. 100.
- <sup>6</sup>*Ibid.*
- <sup>7</sup>Atkins, *Creation*, p. vii.
- <sup>8</sup>*Ibid.*, p. 6, emphasis added.
- <sup>9</sup>Harrison, *Cosmology*, pp. 107-11.
- <sup>10</sup>*Ibid.*, p. viii, emphasis added.

- <sup>11</sup>*Ibid.*, p. 127.
- <sup>12</sup>Carl Sagan, *Cosmos* (New York: Random House, 1980), p. 4.
- <sup>13</sup>Atkins, *Creation*, p. 17.
- <sup>14</sup>*Ibid.*, p. 17.
- <sup>15</sup>*Ibid.*, p. 115.
- <sup>16</sup>*Ibid.*, p. 17.
- <sup>17</sup>*Ibid.*, p. 107.
- <sup>18</sup>*Ibid.*, p. 111.
- <sup>19</sup>*Ibid.*, p. 45.
- <sup>20</sup>*Ibid.*, p. 21.
- <sup>21</sup>*Ibid.*, p. 23.
- <sup>22</sup>*Ibid.*, p. 37.

#### Chapter 9: Sagan's Cosmos

- <sup>1</sup>Carl Sagan, *Cosmos* (New York: Random House, 1980), p. 39; though I refer to the television series, quotations will normally be cited from the published version.
- <sup>2</sup>*Ibid.*, p. 131.
- <sup>3</sup>*Ibid.*, p. 4.
- <sup>4</sup>*Ibid.*
- <sup>5</sup>*Ibid.*, p. 180.
- <sup>6</sup>*Ibid.*, p. 127.
- <sup>7</sup>*Ibid.*, p. 258.
- <sup>8</sup>*Ibid.*, p. 242.
- <sup>9</sup>Sagan, "Cosmos," Episode 12, emphasis added.
- <sup>10</sup>Sagan, "Cosmos," Episode 10, closing lines.
- <sup>11</sup>Sagan, *Cosmos*, p. 176.
- <sup>12</sup>*Ibid.*, p. 173-74.
- <sup>13</sup>*Ibid.*, p. 174.
- <sup>14</sup>*Ibid.*, p. 177.
- <sup>15</sup>*Ibid.*, p. 258.
- <sup>16</sup>*Ibid.*, p. 257.
- <sup>17</sup>Sagan, "Cosmos," Episode 4.
- <sup>18</sup>Sagan, *Cosmos*, p. 333.
- <sup>19</sup>*Ibid.*, p. 345.
- <sup>20</sup>*Ibid.*, p. 250, emphasis added.
- <sup>21</sup>*Ibid.*, p. 4.