

[Coming of Age Under the Night Sky: the Importance of Astronomy in Shaping Worldviews](#)

By Stephen P. Cook

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Abstract

A worldview, an individual's or whole society's conceptual framework for making sense of the world, evolves as it wrestles with such questions as "Why do I see what I see?" While telescopes and spacecraft dramatically expand worldviews in space and time, astronomy began shaping worldviews long ago. Those who watched carefully saw the universe as predictable and orderly rather than magical and chaotic – a conclusion which increased psychological security in individuals and desire for order in society. Spurred by Kepler, astronomy values humbly refining models to fit data. Spurred by Galileo urging critics to look through the telescope, astronomy promotes seeking over believing—something which unites rather than divides people. In challenging anthropocentrism, in tracing the roots of humanity to the ashes of exploding stars, in revealing an image's "pale blue dot" to be Earth, astronomy encourages a "we belong to nature" feeling, as can the beauty of the Milky Way in the night sky. Studying planets made inhospitable by runaway greenhouse effect, investigating the stability of the Sun and nearby aging stars, and monitoring hazards posed by space debris help humankind confront real threats. Complementing astronomy's concern with civilization's premature end is its search for the beginning of the universe. This has long enriched discussion of, and cosmological arguments for, what many individual worldviews are built around: belief in a Creator. Astronomy continues to inspire. Contrast what seeing a comet in the night sky once meant – fear – to what it can mean today: a cause for celebration of humanity's growing up. And someday astronomy may provide an answer to what untold generations of night sky watchers have wondered, "Are we alone?"

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By Stephen P. Cook

Project Worldview, Weed, NM 88354-0499 USA; scook@projectworldview.org

I. Introduction: Worldviews and Astronomy

By worldview, I mean the conceptual framework, beliefs and values used to make sense of reality—something difficult to define.¹ To me reality is everything: all structures—actual and abstract, events and phenomena—observable or not, including feelings. With these definitions, characterizing worldviews is messy. Describing the scientific world picture used to make sense of objective reality—events and phenomena that can be recorded by devices— is easier but still complex. Once understanding or experience enables it, characterizing ultimate reality will be simpler. Physicists dream of doing this: finding the theory of everything; others connect it with finding God.

By astronomy, I mean scientific study of the universe. It didn't start like that—it began with eyes watching the night sky. Scientific knowledge must ultimately be reconciled with observation. The quest for it was inspired by a question, "Why do we see what we see?" Beginning in 1600, Kepler sought to answer this with respect to observed positions of Mars. His struggle to find a hypothesis or model to fit the data is a classic application of the scientific method. To me the year 1609 —when Kepler's 1st Law was published—marks the beginning of modern science. That same year Galileo turned his telescope to the night sky. What he saw validated his belief in

the Copernican worldview and challenged Catholic Church authority. This powerful institution would eventually silence him in perhaps history's most famous clash of worldviews.

Worldviews are used to answer fundamental questions like, "Why am I here?" Long ago I realized that efforts to solve pressing problems are often stalled by differences in worldview. I began to wonder, "How can we help people develop healthy worldviews, ones that will bring happiness and promote planetary well-being?" The topic of worldviews, I soon realized, has two parts: worldview analysis and worldview development.

Worldview development begins in early childhood with concept acquisition. By concepts, I mean abstract generalized ideas and understanding that replace sensory experiences and memories. For example, a young child handles different objects and forms a concept of a sphere. Conceptualization involves observing, abstracting, recalling memories, discriminating, categorizing, etc. Concepts that belong together fit into conceptual schemes; these are used to build a conceptual framework or map.

Your worldview is used to answer "What if...?" questions and to make predictions about the future. Based on feedback you receive, aspects of it get validated, negated, refined, and retested—like doing science and testing hypotheses. My worldview analysis approach attempts to cut through complexity and diversity and characterize worldviews in simplified, manageable fashion. I employ two analogies to describe it: one uses building blocks, the other playing cards. In considering how worldviews develop, the blocks I imagine being used are all different. I call them worldview themes and have eighty of them. Each has a name, number, and description—identifying beliefs, thoughts, feelings, and behavior articulated in similar fashion by lots of people. Many such themes can be used (as a first approximation) in characterizing worldviews.²

As an example, consider my analysis (Cook 2009) of a typical American adult's worldview. The top theme cards held are: Monotheism; Belief in a Personal God; Gratitude & Forgiveness; Valuing Family; Proud Identification; Ethical Orientation; The Consumerist; The Technological Fix Mentality. As we turn our attention to astronomy's role in shaping worldviews, with the exception of the first two and the last, none of these shall concern us. I will argue that astronomy has generally tended to encourage people incorporating the following themes into their worldviews: #1A Humbly Unsure, #4 Global Vision, #6 Scientific Method, #12 The Artistic Worldview, #13 Dancing With Systems, #18B Dispassionate, #27 Belonging To Nature, #29A The Self Restrained Person, #30 Intellectual Freedom, #37B Global Citizen, and #46A The Technological Fix Mentality.

Troubled by my claim that astronomy has promoted both science and art? Consider this: the word cosmos is from the Greek word for order, and The Artistic Worldview (theme #12) involves human creation imposing order on chaos. And consider one of those paradoxical great truths: "The universe created humans" and "Humans created the universe." The first half you can accept, but the second? In this regard consider a book by Anthony Aveni (Aveni 1992). Note its subtitle: *How Science and Myth Invented the Cosmos*.

II. Changing Worldviews: From 1,000,000 BCE to 1,000 BCE

Worldviews are built of concepts. Imagine a time before concepts: the being alive experience is one of wholeness. Before people learn to abstract, to use words and numbers, they unconsciously value "the interconnected unity of [nature's] parts and process"—they appreciate Belonging to Nature (theme #27). We relate their feeling of Oneness to Mysticism (theme #7A). While there may be bliss in their ignorance, there's also painful struggle: they are both hunters and hunted.

While language compromised holistic feeling, it spurred concept development and blossoming of consciousness—also difficult to define. Some understand it by analogy: just as our body moves in real space, our mind moves through mind space. According to Julian Jaynes, "Consciousness is constantly fitting things into a story" (Jaynes 1990). Before this can happen, humans needed to order events in time and gauge time intervals. (In a "humans created the universe" context, this is "the beginning of time.") While they could do this roughly by watching

living things grow, astronomy provided more precise means: using time intervals between successive sunrises (day) or full moons (month) or the sun's changing position (year).

According to Aveni, "Naming the phases of the moon and associating the course of the sun across the zodiac with seasonal activities date back into history as far as any document can reach. It would have been logical to marry the act of story telling about everyday affairs to acts of nature simply as a way to embellish and lend structure to time—to remember how to mark its repeatable cycles."

At some point worldviews began to incorporate the concept of justice. According to Jaynes, "Our sense of justice depends on our sense of time." Aveni builds on this, writing, "There are good reasons for translating normal solar behavior into a concept of justice, for is justice not based on constancy and consistency, on day-to-day reliability?" Consider the idea of weighing both sides of a dispute as in "the scales of justice" (in the sky as constellation Libra). Certainly doing this is promoted by worldviews valuing order and dispassionate (theme #18B) self-restraint (theme #29A). Appreciation of order in the sky helped foster this.

Humans both found order and imposed it. Among the jumble of stars, patterns were recognized. Imaginations saw both familiar figures and heroes to worship. These were linked to stories. The sky became a medium for expression of artistic creativity. At least one of these constellations appears to be truly ancient: Ursa Major. Given the similarity of Eurasian and New World stories, its origin seemingly predates migration of humans across the Bering Strait.³

According to Jacob Bronowski, "the largest single step in the ascent of man is the change from nomad to village agriculture...since civilization on the move can never grow up" (Bronowski 1973). Human beings were metaphorically once children. In the creation myths of over a hundred cultures throughout the world, their parents were the Earth and the Sky. How might these children have related to the night sky?

According to Aveni, ancient Babylonians, Egyptians, and Mayans "believed that they lived in an animated universe...breathing, teeming, vibrant...They talked to the stars, listened to the planets... They saw themselves as mediators in a great universal discourse. At stake was the battle between fate and free will." As reported in surviving texts from earliest human history, gods were connected with tangible, concrete, visible objects in both the sky and on the earth.

A powerful feeling—fear—fostered insecurity in prehistoric people. Ever present, even in ancient Mesopotamian and Egyptian civilizations, were "overtones of anxiety" which Henri Frankfort attributed to "a haunting fear that the unaccountable and turbulent powers may at any time bring disaster to human society."⁴ A clue as to where many looked for guidance can be found in the origin of the word disaster, it means literally ill-starred. People looked to the sky searching for order often lacking in the chaotic terrestrial world. Generally they found it. The "fixed" stars move in the same predictable, reassuring way...But there are seven exceptions: "wandering" stars: sun, moon, and five planets. Planetary retrograde motion was especially troubling.

A dominant belief: one's fate (Fatalism, theme #11A) was written in the stars. Another gave gods human emotions. If they were angry, people suffered consequences. In many cultures, astrologers, holy men, shamans, etc. were needed—both to interpret messages and to placate gods. Today, some laugh at these people and the astrology and magic (theme #7B) their worldviews were based on. Others recognize that they sought what many seek today: a healthy worldview. Fear is not healthy. People fear what they cannot understand—what they can't predict, what doesn't fit into their worldview. They seek to explain what they otherwise would fear. Their stories make sense of natural phenomena, unusual events, of creation itself.

Contrast this view of the ancient Near East, with one of ancient Ireland. As reported by Thomas Cahill, "In virtually all of the Irish tales...we come upon the Celtic phenomenon of shape-shifting... the ability of a being to turn itself into something else...There is within this worldview a terrifying personal implication: that I have no fixed identity but am, like the rest of reality, essentially fluid" (Cahill 1995).

Stories from other cultures capture the tension between order and chaos. Navaho tradition attributes placement of stars in the sky to First Man and First Woman, who initially laid them out on a mat in front of them. Just after they'd positioned the first few in orderly, useful fashion, including the North Star, along came Coyote—that trickster! Grabbing a corner of the mat, he flung the rest into the sky: this is why they seem so randomly placed.⁵

Myths are stories typically featuring gods or demigods as main characters. Oral transmission of them declined as people began writing down sacred stories, and as religions became less polytheistic and more monotheistic. Belief in a single God can be traced to Zoroaster, thought to have lived somewhere in Iran or Central Asia around 1000 BCE. His name, in corrupted Greek, means literally "undiluted stars." We remember him because the religion he founded, in the words of Mary Boyce, "probably had more influence on mankind directly or indirectly than any other faith" (Boyce 1979). From his conception of an ongoing battle between good and evil, one can date the beginning of an important component of many worldviews: "Apocalypticism" (theme #9B). He is perhaps the first prophet to teach belief in an abstract god—one without tangible presence

III. Worldviews: From Ancient Greeks to Christians to 1700

Consider another milestone in the triumph of order over disorder. An important advance occurred in the brief interval of sixty-three years spanning two solar eclipses. Of one he witnessed in 648 BCE, Greek poet Archilochus wrote, "Zeus, the father of the Olympic Gods, turned mid-day into night, hiding the light of the dazzling Sun; and sore fear came upon men"⁶ Yet according to Herodotus, Thales predicted the eclipse of 585 BCE. While Babylonian astronomers ~2000 BCE and others preceded them in quantitatively appreciating the order in nature, by the sixth century BCE, Greeks like Thales and Pythagoras were doing just that.

Christianity was influenced by both Greeks and Zoroastrianism. Monotheism can bolster another powerful feeling—comfort—as St. Patrick and later Irish monks throughout Dark Ages Europe realized. As Cahill described it, "The key to Patrick's confidence... rock solid confidence on which a civilization may be built...is in his reliance on 'the Creator of Creation' Our Father in heaven, having created all things...will deliver us, his children from all evil." Zoroaster's apocalypticism also found a home in Christianity. Unlike monotheism, this can be a source of discomfort. Of Biblical prophecies Marcelo Gleiser writes, "[they] create a state of constant anxiety with regard to cosmic events; every shooting star, every eclipse, every comet or unexpected celestial event may be interpreted as part of the doomsday prophecy, the harbinger of the end to come" (Gleiser 2001).

Church teaching eventually makes Europeans forget the polytheistic pagan past. The Bible gives man dominion over all living things. Man no longer belongs to nature: he is the master of nature. Embracing Anthropocentrism (theme #25), Church cosmology puts Earth at the center of the universe. It asserts a fundamental difference between matter found on Earth and in the heavens, where perfection supposedly reigns. Its details are borrowed from Greeks such as Plato, Aristotle, and Ptolemy.

With publication of his sun-centered system in 1543, Copernicus seriously challenged this cosmology. Both cosmological models sought to make sense out of what is seen in the sky. Galileo's observations, especially of Venus showing phases that are impossible for it to exhibit in Ptolemy's model, dealt the ancient cosmology a staggering blow. Church authorities viewed challenges to its authority and original thinking with alarm. Many refused to look through Galileo's telescope! This telescope did more than make astronomical discoveries. It struck a blow for Intellectual Freedom (theme #30) and bolstered the Enlightenment. That era, says E.O. Wilson, "brought the Western mind to the threshold of a new freedom. It waved aside everything ...to give precedence to the ethic of free inquiry" (Wilson 1998). By 1687, after Newton in *Principia* showed the same physical laws operate both on Earth and in the sky, there was no reason to assume celestial matter fundamentally differed in composition from Earth's. A new mechanistic worldview structure replaced the old one..

IV. Astronomy, Humility, and God

The modern connection between astronomy and humility is a legacy of Copernicus and Galileo. By asserting The Copernican Principle—human beings are not in a privileged place to make observations—cosmologists turn their backs on anthropocentrism and embrace humility. With Galileo's telescope comes humbling appreciation of the universe's vastness and a trend begins: in our conception, the universe grows in size as years pass.

Today we estimate⁷ it contains 70 million million million $=7 \times 10^{22}$ stars—more than the number of all the grains of sand on all of the world's beaches—and has minimum size of 25 to 30 billion light years. The 1965 discovery of the cosmic background radiation provided evidence for a beginning: the Big Bang. We estimate that occurred 13.7 billion years ago. (In a "The universe created humans" context, this is the beginning of time!) These numbers only apply to the observable universe—our universe may be but one of many that make up the multiverse. Even of the observable universe our ignorance is great. Referring to dark matter and dark energy, in 2003 one cosmologist⁸ admitted, "It's embarrassing that 95% of the [observable] universe is unaccounted for."

With so much unknown, doubt seems a good word to use in describing the universe's beginning (if it had one!) I once wrote a metaphorical account (Cook 1990) of creation in which God said "Let there be doubt!"⁹ Where'd I get this? Several places. From physics' Heisenberg Uncertainty Principle; from math's Gödel's theorem; from chaotic systems behavior; from looking at pictures like Voyager's 1990 "pale blue dot" image. Of it, Carl Sagan said, "Look again at that dot. That's here. That's home. That's us...Earth is a very small stage in a vast cosmic arena ... astronomy is a humbling and character-building experience" (Sagan 1994).

Suppose you asked people to respond to the following: "Using one word, name what your worldview is built around." Imagine the answers...Truth. Love. Peace. Family. Work. Survival. Many of you reading this might answer "Knowledge" or "Science." I bet the most popular answer worldwide would be "God." Project Worldview themes most directly tied to God are: #7A Mysticism, #8A Monotheism, #8B Belief in a Personal God, #9A Religious Fundamentalism, and #14A Moralistic God.

"Are astronomers and physicists looking for God?" Yes, in an ultimate reality sense with certain constraints. As scientists, they are involved in testing scientific statements—those capable of being proved false. Many would argue a statement such as "The universe is the creation of an Intelligent Designer" is not scientific. Scientists often approach their work from different perspectives. As Gerald Holton puts it, "There have co-existed in science in almost every period since Thales and Pythagoras, sets of two or more antithetical systems or attitudes ...one reductionist and the other holistic, or one mechanistic and the other vitalistic, or one positivistic and the other teleological" (Holton 1988). Consider two physicists, one an outright reductionist mechanistic positivist, the other more sympathetic to holistic vitalistic teleology.

The first is comfortable with Scientific Materialism (theme #5A), asserts the universe had no Creator, and argues it has no purpose. He sees life as involving physical/chemical processes—not vital spirits—and expects it to someday be created in the lab. Were he to write a book about God and physics, it might resemble *The God Particle* by Leon Lederman (Lederman and Teresi 1993). Despite its title, God is absent from this irreverent book—except in humorous passages. Lederman's hero is Democritus—who first imagined matter can be reduced to atoms. In this tradition, he is searching for the God particle: the Higgs Boson.

Our second physicist also values the Scientific Method (theme #6), which can involve reductionist analysis. But she is less narrowly focused and appreciates insights from chaos/complexity studies and a newer, more holistic, synthesis oriented approach to problem solving: Dancing With Systems (theme #13). Whereas mechanists believe reality is ultimately composed of one thing (matter), this physicist can conceive of it as made of two things: matter and spirit—although she might call it something else: mind, consciousness, etc. Grounded in mainstream materialist perspective, free of scientific constraints she will embrace Vitalism

(theme #5B). A book written by her might resemble *The Mind of God* by Paul Davies. Within scientific boundaries, Davies' book suggests he is searching for God. Dissatisfied with the worldview of our first physicist, Davies' book has a teleological ending: "Through conscious beings, the universe has generated self awareness. This can be no trivial detail, no minor byproduct of mindless, purposeless forces. We are truly meant to be here" (Davies 1992).

While some astrophysicists are atheists, many believe in God. Those who believe the universe is infinite in space and time, and value holism, may be comfortable with Mysticism. This theme's description begins, "While things and events appear to be separate, I believe the perception of discrete objects and the passage of time are illusions." Believing reality is One, mystics strive to experience Oneness and search for God within themselves. Some call the ultimate mystical state cosmic consciousness; others speak of union with God.

Those who believe the universe has a beginning may conceive of God as described in the Monotheism theme: "Creator of the universe." Many astronomers can accept this if it's detached from other connotations. This theme goes on to describe God as "the source of the vital spark that energizes life." Those unable to accept God doing this, but believe life is more than the sum of chemical building block parts, may think of vital spark as mind or consciousness and sign on!

Belief in a Personal God presents problems. It can mean God watches over 1) the entire human species, 2) favored individuals, or both. Scientific justification for this belief is hard to find, although some (mistakenly?) use the Anthropic Principle to provide it. If worldviews end with Monotheism and don't extend to include Belief in a Personal God or Religious Fundamentalism or Moralistic God, divisive beliefs are avoided. Also avoided are difficult questions, such as "Where was God on September 11, 2001?"

In simplest form, monotheism is potentially a great unifying force for humanity—as is seeking not believing, as is holism not reductionism, as is looking at the night sky. Pictures of Earth from space are another such force.

Lacking lines dividing nations, they inspire dreams of a peaceful world of global citizens (theme #37B) and help people appreciate the planet we all call home.

As humble seekers, astronomers can provide two reasons why they're uniquely qualified to shape conceptions of God. First, they study the heavens—where most believe God dwells. Second, with their appreciation of "the big picture," astronomers can help people move away from small, petty, childish, overly detailed, rigidly confining, exclusive conceptions, and toward grander, simpler, liberating, and inclusive ones. Progressing along the path from Moralistic God to Religious Fundamentalism to Personal God to Monotheism to Mysticism is moving in this direction.

While traditionalists may challenge such mysticism, and argue "Seeing God everywhere is seeing Him nowhere," they undoubtedly prefer it to the emptiness of Godless materialism. Certainly mystical conceptions of ultimate reality—especially those incorporating vitalism—more naturally lead to inclusive worldviews, feelings of belonging not alienation, than purely mechanistic conceptions. I'd say someone who believes "a fella ain't got a soul of his own, but only a piece of a big one"¹⁰ is more inclined to become a caring global citizen than an atheist. Holographic models—believing the whole universe is inside the smallest grain of sand, inside you, inside everyone—can produce similar feelings that we're connected to each other.

V. Astronomy, Technology, and Astrobiology

With Galileo's telescope, Global Vision (theme #4) enters the human drama as people take a first step in using technology to extend their senses. Since then, astronomers have possessed a Technological Fix Mentality (theme #46A). Consider milestones in this history of using technology to answer basic questions

. Comte wondered "What are stars made of?" In 1835, he predicted we'd never find out. He was wrong! Astrophysics was born in the 1860s when astronomers began to find an answer. They did it with a technology Comte couldn't imagine: attaching a spectroscope to a telescope and photographing stellar spectra. By the 1930s, efforts to extend astronomer's vision into

regions of the electromagnetic spectrum besides visible light began with the first radio telescopes. In 1990, the dream of placing a telescope in space—above limitations of Earth's atmosphere—was finally realized.

The technology revolution of the last half-century has brought sweeping change to how science is done. Today we often use a systems approach and computer simulation to tackle problems too complicated to approach analytically by solving equations. In promoting global vision, long before new technology gave systems thinking a push, astronomy encouraged an important aspect of it: choosing a system whose boundaries in space and time are big enough to include all that bears on a problem.

A key question for astrobiologists is "How did life begin?" Once this field was dominated by scientific materialists conceiving of life beginning 3.5 billion years ago in terms of random processes in the "organic soup." Seeing life as no more than the sum of its parts, many reductionists don't extend their analysis beyond the molecular level. In contrast, systems thinkers take a broader view and imagine downward causation in which a higher level in the system representation seemingly imposes its will on a lower one. Upon random combination, they impose natural selection with global system constraints. Those who embrace panspermia believe this first happened elsewhere and life came to Earth by hitching a ride on comets.

In confronting social problems, system thinkers often imagine a desired future and design a system with the desired behavior. Take the global climate change problem. Given the key role the energy balance in the Earth—Sun system plays in it, astronomers have made important contributions with studies of 1) "How constant is the energy output of the Sun?" 2) links between cosmic ray intensity, cloudiness, and global temperatures, and 3) Earth's sister planets—Mars and especially Venus, with its runaway greenhouse effect. "How bad could global warming get?"

No one wants wonderfully temperate Earth to turn into a hellishly hot Venus!

Beyond technological fixes, astronomy can promote attitudinal fixes and healthy worldviews. Sagan described one context in which this might happen, "A religion that stressed the magnificence of the universe as revealed by modern science might be able to draw forth reserves of reverence and awe hardly tapped by traditional faiths" (Sagan 1996). Such a religion could inspire belonging to nature feelings and get people outdoors. Dark sky locations with public observatories in naturally beautiful settings could increasingly become destinations—even religious shrines! Bringing children to such places—expanding worldviews—could become a sacred duty of parents.

VI. Astronomy: Coming of Age

I first got involved expanding worldviews as an astronomy teacher, and eventually worked out my version of the ideal sky tour...On an early winter night, after initial orientation, I get to what I really want to share: part of "The Great Story"—our cosmic heritage: nearly fourteen billion years of evolution has resulted in us gazing at the stars in wonder. Before getting to my cycle of stellar evolution theme, I start in a far away galaxy: Andromeda. I tell my audience "The light you're seeing left 2.5 million years ago—when people were little more than animals!"

Telescopic views of Andromeda find me asking them to imagine another galaxy 4.5 billion years ago—the Milky Way—and inside it a giant cloud of gas and dust, roughly 99% hydrogen and helium, 1% heavier elements. To aid imaginations, we view the Orion Nebula and describe the birth of the Sun as part of the cloud collapses. After appreciating how dependable and stable the Sun is, we consider how the Orion Nebula might look a few million years from now by looking at the Pleiades. We then consider stellar energy crises. After eons turning hydrogen into helium, a star runs low on nuclear fuel—and stellar death nears. By now we're examining the aging red supergiant star Betelgeuse and I sing a silly song about it going supernova! I mention the new star Chinese astronomers saw in 1054, we look at the remnant of that supernova event, the Crab Nebula, and note the explosion enriched the interstellar medium.

The cosmic ecology lesson ends with the birth of the next generation of stars. I tell them "We are the ash of stellar alchemy...The iron bound up in hemoglobin giving our blood its red color originated in the nuclear furnace of an old star, was disbursed when the star exploded, and became part of the collapsing cloud that spawned Sun and Earth 4.5 billion years ago." It's both a belonging to nature and recycling story.

Focus on death prompts questions as to how life on Earth will end. Here astronomy puts new life into apocalypticism, with analysis of potential cosmic catastrophes. After downplaying supernova threats, I discuss hazards posed by comets and asteroids—like the six-mile wide piece of rock that did in the dinosaurs sixty five million years ago. I recall a night in 1994 at the campus observatory when we saw what happened after Comet Shoemaker-Levy 9 hit Jupiter. We wondered, "What if it had hit the Earth?"

Comets have a long history of being associated with the wrath of God, the Devil, havoc, and death. Fear of them began to diminish after Halley successfully predicted that the comet seen in 1682 would return 76 years later—demonstrating the power of the scientific method and Newtonian physics. What will the world be like when Halley's Comet returns in 2061? In his 1965 book *Starlight Nights*, Peltier worried that our advanced civilization would end in nuclear holocaust and not make it to that year (Peltier 1965).

Today we are not so pessimistic. In the spirit of Project 2061, some are even hopeful. Perhaps the comet will fly by a world peopled by those whose collective worldview is healthy: they have learned to share, to be tolerant; they feel connected: to each other and to nature... To me this will mark humanity's coming of age. Perhaps someday, the appearance of a comet will be a cause for celebration of humanity's growing up.

That won't mean the human species has met all challenges: I can think of two it may confront in the near future. The first will begin with an astronomer finding an asteroid with an Earth crossing orbit. Perhaps technology can be used to alter its course and prevent disastrous collision. Perhaps humanity will demonstrate it has grown up and is capable of protecting itself from hazards lurking in space. The second will be of a different nature, but it too will involve astronomers from the outset. Its ramifications will shake the worldview of nearly every thinking person. It will come with the answer to what sky watchers have always wondered, "Are we alone?"

Someday our childhood will end.¹¹ Earth and Sky have been considered our parents in various mythologies. In summarizing the importance of astronomy in shaping worldviews, I credit our Sky parent with teaching us there is order in how the world works, and giving us global vision to see through space and time. As Bronowski put it, "There are many gifts unique to man, but at the center of them all...lies the ability to draw conclusions from what we see to what we do not see, to move our minds through space and time." Today we honor the successes Kepler and Galileo had in doing this long ago. Someday, we'll celebrate our species' coming of age under the night sky.

NOTES

1. see "Letters," in *Physics Today*, Sept. 2009, vol. 62, #9; pp.10-15
2. see www.projectworldview.org for details
3. Bradley Schaefer, "The Origin of the Greek Constellations," in *Scientific American* Nov. 2006; pp 96-101
4. Nancy Sandars, "Introduction" in *The Epic of Gilgamesh* London: Penguin Books, 1972
5. Janet M. Cliff, private communication
6. Duncan Steel, *Eclipse* London: Headline Book Publishing, 1999
7. Simon Driver, 7/23/2003 news item <http://www.cnn.com/2003/TECH/space/07/22/stars.survey>
8. Martin Rees, "Our Complex Cosmos and its Future," in *The Future of Theoretical Physics and Cosmology* Cambridge: Cambridge University Press, 2003
9. I find this intriguing: $\text{doubt} \leftrightarrow \text{uncertainty}$, which per Heisenberg has units of energy x time—the same units as action (as in The Principle of Least Action). Perhaps God simply said, "Action!"
10. from John Steinbeck's *The Grapes of Wrath*
11. I must cite Arthur C. Clarke's mystical classic *Childhood's End*

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