



# *Cosmophobia: Urania's Lament and Lessons Learned*

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## INTRODUCTION

It will come as no surprise that the world did not end on December 21, 2012. No rogue asteroid slammed into our planet, no humongous solar flare evaporated our atmosphere, and the planet did not catastrophically flip over on its axes. The next day holiday shopping still needed to be completed, bills demanded to be paid, and deadlines still loomed. Tourists began leaving Mexican and Central American archaeological sites, their wallets lightened and perhaps their spirits lifted (Sood 2012). In China, a carpenter who had spent his entire family savings on fine food and wine in the days prior to the 21<sup>st</sup> was probably trying to apologize to his now-estranged pregnant wife, and two cousins who had gone on a pre-apocalypse crime spree were probably rethinking the wisdom of their recent life choices (Zhong 2012). In the wake of the non-end of the world, the only casualties seem to have been some gullible persons' bank accounts, and the UNESCO World Heritage site Temple II in the Mayan metropolitan center of Tikal, which suffered unspecified damage when tourists illegally climbed its ancient steps (AFP 2012).

The sunrise on December 22, 2012 especially came as no surprise to scientists, some of whom had been debunking these illogical claims for the previous few years, in what was probably the largest anti-pseudoscience public education campaign by the scientific community in modern history.



NASA even posted their “I told you so” video and accompanying news story – “Why the world didn’t end yesterday” – ten days prior to the dreaded date (Phillips 2012). In the wake of the apocalypse-that-wasn’t, it would be easy for the scientific community to simply pat itself on the back, and leave the retrospectives to the historians and psychologists who have studied previous failed end-of-the-world predictions. However, to do so would be a grievous error, for this particular incident was singular, not only in its scope and mode of popularization, but equally important, in the response of the scientific community. Well before the arrival of the dreaded date, scholars from myriad fields were investigating the ever-growing Internet and media coverage of this phenomenon, both with a mind to debunk the various claims and to understand how the phenomenon itself had grown to permeate the public consciousness (Gelfer 2011). Now that the dooms-date has passed, there are important lessons to be learned from the 2012 apocalypse hoax, not only by social scientists and media experts, but the science and education communities as well. A complete reconstruction is beyond the scope of this paper; indeed, entire PhD theses can and undoubtedly will be written about the science community’s response to this educational crisis. The present goal is to summarize what the author has come to understand, in her role as a science educator and a very active participant in the 2012 apocalypse debunking movement, to be some of the salient take-away messages from this very teachable moment.

#### COSMOPHOBIA, PAST AND PRESENT

Some time around 2008 there was a notable shift in the school-age audiences in the Copernican Planetarium at Central Connecticut State University. Students no longer inquired what would happen if one fell into a black hole; rather, they were earnestly concerned as to whether or not they would die at the end in 2012 due to some astronomical calamity. College students also began referencing such concerns in class assignments, usually tied to a vague notion that the Mayan calendar would end that year. Similar scenes were simultaneously playing out in planetaria, classrooms, and scientists’ email inboxes across the globe. One of the first to bring attention to this disturbing new trend was NASA astrobiologist David Morrison, whose “Ask an Astrobiologist” (<http://astrobiology2.arc.nasa.gov/ask-an-astrobiologist/>) blog’s inbox became increasingly flooded with questions about supposed astronomical threats. From a hypothetical asteroid/alien spacecraft dubbed Nibiru and purported alignment of the sun with the galactic center, to a calamitous shift of the earth’s magnetic (or even rotational) poles, catastrophic supernova explosion, or violent solar outburst, the general public increasingly seemed to consider the heavens to be the enemy. Gone was the classical depiction of astronomy in the form of the beautiful Urania, a source of inspiration to poets and physicists alike; now it seemed the



universe had been anthropomorphized into a monstrous form, more akin to the one of the Furies of mythology, hell-bent on destruction with our fragile planet squarely in her bloodied cross-hairs.

Morrison reports that he answered as many of the emails as possible, easily debunking the astronomical threats posed. He then educated himself on a common thread tracing through many of these queries, namely the mistaken view that the Mayan Long Count calendar not only ended on December 21, 2012, but that there existed Mayan prophecies that the date would also mark the catastrophic end of Planet Earth. What disturbed Morrison the most was the increasing number of queries from frightened children (some of whom openly contemplating suicide), as well as from parents and teachers. In response, he not only began posting FAQ sheets, YouTube videos, and blogs directly addressing these concerns head on, but coined the term “cosmophobia” – fear of the cosmos” in response (Morrison 2009: 5). As the 2012 apocalypse hoax grew in the popular imagination, so did Morrison’s personal battle against these rumors and misrepresentations of science. His chief concern was that a pervasive fear of not only individual astronomical events and discoveries, but the universe as a whole, could very well outlast the arrival of December 21, 2012 itself, and become “one of the worst long-term consequences” of this phenomenon (Ibid.: 6).

Such a seemingly irrational fear seems out of place in a modern, technological society, one in which the causes of eclipses, aurora, meteor showers, and comets – commonly the sources of astronomical fear in the pre-Scientific Revolution world – are well-understood and demystified. But in order to understand how such a modern cosmophobia could not only develop, but take hold of a significant portion of the population, it is necessary to understand how the average person’s experience of the universe differs from that of ancient ancestors. In the ancient world, the order of the universe was evident to anyone with a sense of vision and the patience to make observations over time. The cycles of the rising and setting of the sun, the phases of the moon, and the return of the seasons were obvious and dependable, and were used to mark the passage of time. The stars made patterns (constellations), some of which were visible each night and could be used for navigation (such as our Big and Little Dipper), while others could only be seen at certain times of the year. Other cycles were also apparent, such as the motions of the naked eye planets, especially Venus, the brightest object in the sky after the sun and moon. The regularity of the heavens was a source of comfort and constancy, in sharp contrast to the terrestrial world of uncertainty and change (including storms, war, sickness, and death). Therefore all ancient cultures not only monitored the heavens carefully, but made note of these patterns and revered them (Aveni 1980: 3). Interruptions to this order – transient objects like eclipses, meteors, comets, auroras, and supernovae that appeared without warning – were the source of fear, and considered evil omens.

Today it is not uncommon to hear a television weather forecaster inviting his or her viewers to step outside on a given night to view a particular meteor shower, as



such events can now be predicted with regularity. But despite such media sound bites and the fact that on any clear night an observer can usually see several “shooting stars”, the general public has a short attention span when it comes to scientific knowledge. For as anyone employed by a planetarium, science center, or astronomy department knows all-too-well, when an especially bright meteor is seen, telephone lines and email inboxes are flooded with concerned questions about what “that bright light” was in the sky. Even the evening apparition of the planet Venus can spark concerned calls from the general public or reports of a UFO. The problem is three-fold, and central to understanding how the 2012 apocalypse hoax became such a phenomenon: modern society has lost its connection to the night sky, the average citizen is lacking in basic science knowledge, and belief in pseudosciences (such as UFOs) is rampant.

It is a sad fact that the average adult in an industrialized nation today knows less about the visible night sky than the average ancient Athenian citizen, Mayan farmer, or Egyptian priest. The ancient Maya not only monitored the apparent motions of the sun and moon (and used them in their various calendar systems) but also noted the motions of the visible planets, most especially Venus (Aveni 1980: 86). The Maya, like other ancient stargazers, knew through continued observations that Venus always appears within about 45 degrees of the sun (now known to be caused by the fact that it orbits closer to the sun than our own planet). This fact is all but lost in modern society, leading to common misidentifications between Venus and Jupiter, an only slightly less brilliant planet. For example, a friend of the author who is also a retired English professor from a well-known college recently declared on Facebook that Venus was visible in the northeast early evening sky next to the full moon. Any Mayan, ancient Greek, or Medieval monk would have known this to be impossible. When the average citizen does look at the sky, the constellations are unfamiliar, and the bright stars only take on individual identities with the help of a cellphone app. Even the most basic of celestial cycles are largely unidentifiable by modern humans. When asked what the length is of the moon’s cycle of phases, only 40% of the 660 college students asked could narrow it down to between 29 and 30 days (Larsen 2012: 29). College students also do not understand the basics of our modern calendar; only about a quarter of 267 students polled could explain why leap years occur every four years (Ibid.: 28). It is no wonder, then, that many in the general public ascribe some mysterious and malevolent nature to the unfamiliar Mayan calendar (whose base-20 cycles additionally seem unnatural to the math-phobic).

While the modern public’s lack of understanding of the night sky is lamentable, it is not unexpected. Before the invention of the electric light bulb, our ancestors enjoyed an intimate link with the heavens above. Thousands of stars could easily be seen on a clear night. Such is no longer the case, with many modern city residents unable to see more than the brightest of stars above the luminous din of light pollution. For example, a 2006 study by the British Astronomical Association found



that more than half of participants could only see 10 of the potentially 250 naked eye stars in Orion (Claudio 2009: A29), and 63% of humanity lives in an area where the Milky Way cannot be seen with the naked eye (Chepesiuk 2009: A22). The universe is therefore largely out of sight, and out of mind, to the average citizen, unless an item in the media draws attention to some out-of-the-ordinary event. For far too many children, the night sky is something that is only experienced in a planetarium. Not only does light pollution rob children of an awe-inspiring experience that sparked the interest of previous generations of astronomers, but it also creates a generation of readers of poetry and prose that increasingly does not understand the astronomical allusions contained in classic works (Larsen 2011: 17). Light pollution has also been shown to harm wildlife and reduce the visual acuity of elderly drivers, and has even been implicated in increased rates of breast cancer. For these reasons, the American Medical Association voted to support astronomers' battle against light pollution (Motta 2009).

Not only is the average person unfamiliar with the night sky, they are also largely ignorant of basic facts of scientific knowledge. For example, the science literacy of the American public has been measured for more than a decade through a nine question survey. The results have stagnated at around 60% during this time, with other industrialized countries demonstrating similar results (National Science Board 2012: 7-23). Another set of questions probe the public's understanding of scientific inquiry, and in 2010 only 42% of Americans polled understood the proper use of probability, experimental design, and the scientific method (Ibid.). While scores on such literacy tests do improve with higher levels of formal education, numerous studies have shown that college graduates, including school teachers, not only have misconceptions concerning basic scientific facts and methodologies, but that these misconceptions are difficult to correct in the course of a standard liberal arts and sciences college education (Impey, Buxner, and Antonellis 2012: 7).

A related problem is widespread belief in pseudosciences and the paranormal. For example, approximately three-quarters of the American public admits belief in at least one such phenomenon (Moore 2005). One-third of Americans believe in UFOs and 10% actually claim to have seen one (Harish 2012). Such beliefs are found worldwide; for example, in a 2001 European Union poll 53% of respondents thought astrology was scientific (National Science Board 2006: A7-15). The purveyors of the 2012 apocalypse hoax therefore found a receptive and highly gullible audience in a public that is unaware of the visible universe, does not understand the scientific method, and cannot discern the difference between science and pseudoscience. These connections need to be understood in order to prevent a repeat of the 2012 apocalypse phenomenon in the future. A fourth important aspect of the public's response to 2012 apocalypse hoax is, of course, the pervasiveness of apocalyptic beliefs in modern culture. A detailed discussion of this aspect is beyond the scientific scope of this paper, but has been treated elsewhere (Gross 2012).



## 2012: THE PERFECT STORM

Not only was the general public a receptive audience for the aggregate of pseudosciences that formed the core of the 2012 apocalypse phenomenon, but technology played a vital role in the dissemination of the numerous individual claims drawn from pseudosciences, pseudo-history, and fringe interpretations of various religious texts. The result was the creation of the widest-reaching collection of aggregated scare tactics in the history of human communication. Before the invention of the printing press, apocalyptic predictions were spread by word of mouth, or through hand-copied or block-pressed documents. Beliefs were confined by geography or language, and doomsday soothsayers had to work hard to spread their message. But with improvements in technology came the ability to spread ideas across a continent, or the entire globe. For example, William Miller and his apocalyptic Millerite movement in the 1800s were highly successful in spreading their message due to the use of high speed printing presses to mass produce pamphlets and newsletters (White 1999). In the 20<sup>th</sup> century, ideas could be spread nearly instantaneously, at first through radio and television, and later through the Internet. Hollywood found a ready audience for disaster films and television shows, from the original *War of the Worlds* radio broadcast through *Godzilla*, *Deep Impact*, *The Walking Dead*, and countless others. In the post-9/11 world, apocalyptic media became increasingly popular, especially in the United States, from documentaries and political discussions to obvious fictional depictions of the end of either human civilization or the entire planet (Walliss and Aston, 2011: 53). The *Science Fiction* (later *SyFy*) *Channel* was an early embracer of apocalyptic media, proudly declaring their weekly Saturday night run of original disaster movies "the most dangerous night on television."

In addition to its stable of science fiction and horror films and television series, the *SyFy Channel* also increasingly developed a cache of original programming that focused on pseudosciences and the paranormal, such as *Ghost Hunters*, which presented supposedly scientific investigations of these decidedly non-scientific topics. More disturbingly, *The History Channel* began mass-producing quasi-documentaries about pseudoscientific topics such as the writings of Nostradamus, further blurring the line between truth and fiction. It was against this backdrop that the 2012 apocalypse hoax burst forth on the Internet. In response, ratings-conscious networks openly embraced the public's growing interest in (and lack of discriminating understanding of) the supposed end of the Mayan Long Count calendar and the host of supposed astronomical catastrophes that became attached to December 21, 2012. Roland Emmerich's 2009 blockbuster *2012* was the final icing on the cake, bringing awareness of the 2012 apocalypse scenarios to the remainder of the media-consuming population.



But despite all the television shows, disaster films, and hundreds of books that cashed in on the public's interest in the 2012 predictions, the Internet was clearly responsible for the speed with which these apocalyptic ideas spread, and their ultimately worldwide dissemination. From viral emails and discussion boards to blogs, YouTube videos, Twitter tweets, Facebook pages and voluminous websites, it was nearly impossible to avoid these claims. Much of what was presented was couched in scientific lingo, but not only lacked the fact-checking and peer-review of scientific literature, it was quite simply flat wrong. However, as has already been noted, the average citizen is not in a position to know whether or not what they are reading online is science or pseudoscience. Given that the Internet and television are each the primary source of information about science and technology for 35% of the American public, it was perhaps inevitable that the 2012 phenomenon would reach the fever pitch that it did (National Science Board 2012: 7-10). It was, quite simply, the perfect pseudoscience storm.

David Morrison had become aware of the 2012 phenomenon through his "Ask the Astrobiologist" blog in late 2007, and as noted above, very quickly became involved with debunking the various claims. But his was initially one of very few voices raised against the coming storm, as historically most scientists have been reticent to become involved with debunking pseudosciences. For example, Harvard astronomers Bart Bok and Margaret Mayall noted as they began their own private war on astrology in 1941 that "active concern in the spreading of astrology has generally been considered beneath the dignity of scientists." They countered that "it can hardly be denied that it is one of the functions of scientists in a democracy to inform the public about the nature and background of a current fad, such as astrology, even though to do so may be unpleasant" (1941: 233). Indeed, in the decades after Bok and Mayall's initial salvos, few scientists took up the charge, the most important exceptions including Carl Sagan and Phil Plait. As an example, astronomer Mike Brown noted quite plainly on his blog "I don't answer emails from pseudo-scientists" (Brown 2008). Therefore the 2012 apocalypse was initially ignored by much of the scientific community, perhaps with a thought that it would just harmlessly blow over like other previous end-of-the-world predictions.

But the increasing volume of questions from the general public, especially from frightened children, quickly painted this as a very different event. In addition, some in the astronomical community began drawing troubling connections between these claims and those made in 1996-1997 about Comet Hale-Bopp. At that time, rumors were rampant on the Internet (fueled by AM radio shows that catered to conspiracy theories and pseudosciences, such as Art Bell's *Coast to Coast*) that Comet Hale-Bopp was either under alien control, or that an alien spacecraft was hiding behind the comet or within its tail. One of the most vocal debunkers of these claims was co-discoverer of the comet, astronomer Alan Hale. Not only was he personally disturbed at the lack of critical thinking displayed by those who spread these claims, but he realized that this



“comet madness” should be taken seriously by the scientific community. He warned that

The fact that claims such as these receive such widespread acceptance among large segments of the general public is not something that we scientists and rationalists should dismiss lightly. [...] It is imperative that we, the scientists and rationalists of today, diligently work toward alleviating this scientific illiteracy (Hale 1997: 28).

Hale’s warning proved eerily timely, for at the same time that his article appeared in print in March 1997 (during the comet’s closest approach to earth), 39 members of the Heaven’s Gate cult committed suicide in California, leaving their bodies behind in the misguided hope that they would ascend to the spacecraft they believed to be associated with the comet (Bader 1999: 123-4).

By 2007 there were increasing claims that the end of the world on December 21, 2012 would be caused by some astronomical catastrophe, including the supposed rogue planet/asteroid/alien spacecraft Nibiru, and it was natural that some would worry about another Heaven’s Gate-type event. For example, in his debunking of the claim that December 21, 2012 would mark an alignment of the sun with the center of the galaxy, Geoff Gaherty warned that he was “deeply concerned that the promoters of this 2012 Doomsday ‘event’ might precipitate another such deadly massacre” (Gaherty 2008). Given these concerns, some well-known names in the astronomy outreach/education community began joining Morrison in debunking the increasing tide of misinformation concerning December 21, 2012. Among these were E.C. Krupp, archaeoastronomer and Director of the Griffith Observatory in Los Angeles, and Neil DeGrasse Tyson, astrophysicist and Director of the Hayden Planetarium at the American Museum of Natural History in New York City. New voices also joined the battle, such as solar astronomer Ian O’Neill, a contributor to the Universe Today and Discovery Channel News websites, and Don Yeomans, NASA planetary scientist and expert on comet and asteroid orbital dynamics. Given that the 2012 apocalypse hoax was largely being spread through the Internet and social media, the fight to debunk and defuse these claims was also largely waged using the same tools. A Google search of any of the above names will yield references to numerous YouTube videos, blogs, podcasts, and website pages crafted to combat the 2012 pseudosciences. Twitter and Facebook accounts were also widely used.

Not only were individual scientists and science educators involved in debunking these claims, but astronomical organizations as well. Planetariums and science centers hosted public lectures and integrated debunking of the 2012 apocalypse hoax into their public programming. Social media and websites were also utilized by these astronomy education and outreach organizations in order to reach greater audiences beyond their normal foot traffic (Larsen 2010: 13).





The Astronomical League, an umbrella organization for astronomical societies across the United States, issued an official statement against the “fanciful stories floating on the Internet claiming that the Earth will face destruction in December 2012” (Astronomical League 2011: 1). In January 2009, a group of amateur astronomers, engineers, and other scientifically-minded people founded the website 2021hoax.org, devoted to collecting and debunking various claims made by the 2012 apocalypse community. It became a one-stop-shop source of information for the general public, including articles debunking specific doomsday scenarios (such as a super-eruption of Yellowstone and a galactic alignment), and a very active discussion board. William Hudson (aka Astrogeek), the main site administrator, was interviewed by numerous media outlets, leading to further dissemination of the website’s name and URL. For example, on December 16, 2012 alone the site was visited by over 20,000 individuals (Astrogeek 2012).

As the content of the 2021hoax.org site clearly demonstrates, it was not only astronomical topics that were hijacked by the doomsday claimants, but geology and, most importantly, the Mayan culture. It was therefore imperative that experts in these fields also become intimately involved in the debunking process. For example, after giving public talks concerning the geological pseudosciences included in the 2012 apocalypse phenomenon, The College of Wooster (Ohio) geologist Mark Wilson (2010) posted his PowerPoint presentation on the Internet in order to help other geologists become involved in the process, and Maya expert Mark Van Stone (2008) created a detailed website with information concerning the true cycles of the Mayan calendar, and Mayan culture more generally.

Clearly the leaders in the professional astronomical community’s attack on these claims were David Morrison and the Astronomical Society of the Pacific (ASP). As noted above, Morrison was one of the first to take note of the phenomenon, and his “Ask An Astrobiologist” blog on the NASA website quickly changed its focus to debunking the 2012 apocalypse claims. Between 2008 and the end of 2012 Morrison became the unofficial face of this movement, taking advantage of not only social media and the Internet, but also the traditional media’s increasing interest in the phenomenon, and produced informational interviews, videos, websites, and articles in addition to presentations at professional conferences and for the general public. Morrison admitted that he had become “somewhat obsessed” with debunking the 2012 apocalypse claims, and getting others in the scientific community to do so as well (Duray 2012). The Astronomical Society of the Pacific, an organization of professional and amateur astronomers and educators, became deeply involved in debunking the 2012 apocalypse hoax beginning in 2009. For example, the society’s Executive Director James Manning devoted his November/December 2009 column in the American Astronomical Society newsletter to urging the American astronomical community to become involved with the debunking movement, noting “This is a teachable moment. So let us teach” (Manning 2009: 14). The ASP took the unusual move of making the



September 21, 2009 issue of its members-only online column *Astronomy Beat* open to all readers. The topic was an invited article on cosmophobia and the 2012 hysteria by David Morrison. The winter 2012 edition of the organization's public education newsletter *The Universe in the Classroom* also focused on teaching and debunking the 2012 apocalypse phenomenon (Enevoldsen 2012). The 2012 annual meeting of the ASP featured a plenary session and two workshops devoted to debunking the 2012 phenomenon, organized by former ASP Executive Director Andrew Fraknoi, David Morrison, Mark Van Stone, UC Berkeley astronomer and educator Bryan Mendez, and this author. A video of the plenary session was posted on the NASA website, accompanied by other resources written by David Morrison (Morrison 2012). Finally, the ASP declared December 12, 2012 "Take Back the Calendar" day, an "Anti-Doomsday Day" celebrating "rational thinking and reasoned discourse" (Harper 2012).

#### LESSONS LEARNED AND FUTURE PLANS

December 22, 2012 dawned and the world was still here, with no mass suicides having taken place. However, earlier in the month a knife-wielding man had stabbed 23 school children in China, reportedly in response to the impending end of the world (Walker 2012), and police in China and Brazil had previously rounded up members of doomsday cults in order to prevent a repeat of the Heaven's Gate massacre (Xu 2012; Mackenzie 2012). When interviewed two months before the winter solstice, David Morrison voiced the hope that the subject would finally disappear forever at the end of the year: "I've never dealt with anything like this before and I hope I never have to deal with it again" (Atkinson 2012). However, given the long history of failed apocalypse predictions, this hope is vain at best. More disturbingly, an early 2012 international poll found that 14% of respondents expect the world to end in their lifetime (Gottfried 2012). Even before the arrival of the end of B'aktun 13, the next doomsday scenario was already looming on the horizon, in the form of two asteroids. The first, dubbed 2012 DA14, passed safely below the orbits of geostationary satellites on February 15, 2013, despite "fear, uncertainty, and doubt" propagated by conspiracy websites (Galache 2012). The second object, Apophis – named for the Egyptian god of evil and destruction – has been dubbed a "killer asteroid" by some in the media; anxiety is already rising on the Internet concerning its close approaches to the earth in 2029 and 2036 (Noland 2006). Cosmophobia has become one of the most unfortunate lingering aftereffects of the 2012 apocalypse phenomenon, just as David Morrison had predicted. Perhaps the next meteor shower one sees may metaphorically be thought of as the tears of Urania.



Having won the 2012 battle, it appears the greater pseudoscience war wages on. For example, the 2012hoax.org website has been retired and archived online, and replaced with a new cosmophobia.org site that will continue to focus on debunking astronomical hoaxes and misinformation. The number of hits to the 2012hoax.org website and emails sent to David Morrison demonstrate that many in the public want reliable scientific information concerning claims that are made in the media. In the words of *New York Times* columnist David Pogue, "People are essentially frightened by what they don't understand" (Kramer 2012: 24). In order to satisfy this need, there must be scientists and science educators who are willing and able to provide timely, engaging, and accurate materials. However, as Carl Sagan noted, "some scientists believe the public is too ignorant or too stupid to understand science, that the enterprise of popularization is fundamentally a lost cause, or even that it's tantamount to fraternization, if not outright cohabitation, with the enemy" (1997: 334). This prejudice is seen in academia, where popularizations of science and community engagement are often not given proper credit in the promotion and tenure process. But as Ann Shteir argues, the skills possessed by a successful popular science writer are different from, not inferior to, those of a successful researcher. In her words, "The creation of knowledge and the dissemination of knowledge are equally important to science culture" (1996: 101).

Fortunately, the tide appears to be turning. A 2012 colloquium at the National Academy of Sciences focused on the topic of communicating science with the public, and noted the importance (and difficulty) of successful popularizations. Among the difficulties is the simple fact that not all scientists are effective communicators (Kramer 2012: 23). A three-pronged approach is therefore recommended: first, professional development in effective communication should be provided for interested scientists; second, those scientists who have a track record of effective communication with the public should be acknowledged, supported, and rewarded for such efforts; and lastly, scientists should work closely with science journalists and science education and outreach professionals to make sure that accurate, high quality information is made available to the general public. In addition, a straightforward program of debunking – the removal of fear – is not sufficient to make long term changes in the public's mindset. Instead, it is necessary to replace fear with wonder, or cosmophobia with *cosmophilia*. If children are no longer asking what happens when one falls into a black hole, perhaps the question should be posed for them within the script of the planetarium show. If the public is frightened about the sunspot cycle, rather than just stating that there is nothing to worry about, they should be given the opportunity to view sunspots safely for themselves. The year 2013 will potentially feature two naked eye comets, PANSTARRS (which was visible in March) and ISON (coming near the end of the year) (Byrd 2013). Undoubtedly some on the Internet will spread doomsday rumors about these two celestial vagabonds; however, just as Alan Hale encouraged astronomers to help the public observe Comet Hale-Bopp for themselves, the



response should center around inviting and encouraging others to see the universe as scientists do, and to understand that “the pursuit of knowledge of the real world and universe around us is far more ‘fun’ than pseudoscience could ever be” (Hale 1997: 28).

#### WORKS CITED

AFP, “Mayan Temple II at Tikal Irreparably Damaged in End of World Party”, 24 December 2012, <<http://www.dailytelegraph.com.au/news/mayan-temple-damaged-in-end-of-world-party/story-e6freuy9-1226542860897>> (2 January 2013).

Aveni A. F., 1980, *Skywatchers of Ancient Mexico*, Texas U.P., Austin.

Astrogeek, “90-Day Stats through December 16<sup>th</sup>”, 17 December 2012, <<http://www.2012hoax.org/forum/t-604133/90-day-stats-through-december-16th>> (2 January 2013).

Astronomical League, “Debunking the December 2012 Doomsday Claims”, 12 December 2011, <<http://www.astroleague.org/files/articles/goss/WorldEndsDecember2012.pdf>> (27 December 2012).

Atkinson N., “How Have the 2012 Doomsday Myths Become Part of our Accepted Lexicon?”, 22 October 2012, <<http://www.universetoday.com/98130/how-have-the-2012-doomsday-myths-become-part-of-our-accepted-lexicon>> (27 December 2012).

Bader C., 1999, “When Prophecy Passes Unnoticed”, *Journal for the Scientific Study of Religion* 38, pp. 119-131.

Bok B. J. and M.W. Mayall, 1941, “Scientists Look at Astrology”, *The Scientific Monthly* 52 no. 3, pp. 233-244.

Brown M., “I do not [Heart] Pseudo-science”, 2 February 2008, <<http://www.mikebrownsplanets.com/2008/02/i-do-not-pseudo-science.html>> (27 December 2012).

Byrd D., “Big Sun-diving Comet ISON Might Be Spectacular in late 2013”, 3 January 2013 <<http://earthsky.org/space/big-sun-diving-comet-ison-might-be-spectacular-in-2013>> (4 January 2013).

Chepesiuk R., 2009, “Missing the Dark: Health Effects of Light Pollution”, *Environmental Health Perspectives* 117 no.1, pp. A20-27.

Claudio L., 2009, “Switch on the Night: Policies for Smarter Lighting”, *Environmental Health Perspectives* 117 no. 1, pp. A28-A31.

Duray D., “The NASA Scientist who Answers your 2012 Apocalypse Emails”, 4 September 2012, <<http://www.theawl.com/2012/09/nasa-apocalypse-expert>> (27 December 2012).



Enevoldsen A., 2012, "2012", *The Universe in the Classroom* no. 79, <<http://astrosociety.org/edu/publications/tnl/79/79.html>> (23 December 2012).

Gaherty G., "Starry Night Looks at Doomsday", June 2008, <<http://www.starrynighteducation.com/sntimes/2008/06/index.shtml#art1>> (30 December 2012).

Galache J. L., "Clearing Up the FUD On 2012 DA14", 12 March 2012, <<http://minorplanetcenter.net/blog/clearing-up-the-fud-on-2012-da14>> (30 December 2012).

Gelfer J. (ed.), 2011, *2012: Decoding the Countercultural Apocalypse*, Equinox Publishing, Sheffield (UK)

Gottfried K., "One in Seven (14%) Global Citizens Believe End of World is Coming in their Lifetime", 1 May 2012, <<http://www.ipsos-na.com/news-polls/pressrelease.aspx?id=5610>> (4 January 2013).

Gross M.B. and M. Gilles, 2001, *The Last Myth: What the Rise of Apocalyptic Thinking Tells us About America*, Prometheus Books, Amherst (NY).

Hale A., 2007, "Hale-Bopp Comet Madness", *Skeptical Inquirer* 21 no. 2, pp. 25-28.

Harper K., "ASP declares 12/12/12 Anti-Doomsday Day", 12 December 2012, <<http://astrosociety.org/get-involved/anti-doomsday-day/>> (15 December 2012).

Harish A., "UFOs Exist, Say 36 Percent in National Geographic Survey", 27 June 2012, <<http://abcnews.go.com/Technology/ufo-exist-americans-national-geographic-survey/story?id=16661311>> (4 January 2013).

Impey C., S. Buxner, and J. Antonellis, 29 October 2012, "Non-Scientific Beliefs Among Undergraduate Students", <[http://aer.aas.org/resource/1/aerscz/v11/i1/p010111\\_s1](http://aer.aas.org/resource/1/aerscz/v11/i1/p010111_s1)> (20 December 2012).

Kramer D., 2012, "Scientists Share Blame for Public's Ignorance of Science", *Physics Today* 65 no. 7, pp. 23-24.

Larsen K., 2010, "Planetaria and 2012 Hysteria", *Planetarian* 39 no.1, pp. 13-14.

Larsen K., 2011, "And the Stars Were Hidden: Middle-earth as a Canary in the Light Pollution Coal Mine", *Amon Hen* no. 229, pp. 16-18.

Larsen K., 2012, "Leap Year, 2012, and Lunar Calendars", *Connecticut Journal of Science Education* 49 no. 2, pp. 26-31.

Mackenzie, C., "Shots Fired as Police Swoop 10 Minutes before 100 Followers of Brazilian Doomsday Cult Were Due to Commit Mass Suicide over End of the World," 12 October 2012, <<http://www.dailymail.co.uk/news/article-2216743/Shots-fired-police-swoop-10-minutes-100-followers-Brazilian-doomsday-cult-commit-mass-suicide-world-ended.html>> (4 January 2013).

Manning J., 2009, "Addressing the 'Science' of Doomsday", *AAS Newsletter* no. 149, p. 14.



Moore D. W., "Three in Four Americans Believe in Paranormal", 16 June 2005, <<http://www.gallup.com/poll/16915/three-four-americans-believe-paranormal.aspx>> (29 December 2012).

Morrison D., 2009, "Doomsday 2012, the Planet Nibiru, and Cosmophobia", *Astronomy Beat* no. 32, <<http://astrosociety.org/2012/>> (27 December 2012).

Morrison D. "Cosmophobia and the End of the World 2012", 2012 <<http://lunarscience.nasa.gov/articles/cosmophobia/>> (27 December 2012).

Motta M., "U.S. Physicians Join Light-pollution Fight", 22 June 2009, <<http://www.skyandtelescope.com/resources/darksky/48814012.html>> (27 December 2012).

National Science Board, 2006, "Science and Engineering Indicators 2006", National Science Foundation, Arlington (VA).

National Science Board, 2012, "Science and Engineering Indicators 2012", National Science Foundation, Arlington (VA).

Noland D., "Five Plans to Head off the Apophis Killer Asteroid", 6 November 2006, <<http://www.popularmechanics.com/science/space/deep/4201569>> (4 January 2013).

Phillips T., "Why the World Didn't End Yesterday", 11 December 2012, <[http://science.nasa.gov/science-news/science-at-nasa/2012/14dec\\_yesterday](http://science.nasa.gov/science-news/science-at-nasa/2012/14dec_yesterday)> (20 December 2012).

Sagan C., 1997, *The Demon-haunted World*, Ballantine Books, New York.

Shteir A. B., 1996, *Cultivating Women, Cultivating Science*. Johns Hopkins U. P., Baltimore.

Sood S., "'End of the World' Hysteria Boosts Tourism", 14 December 2012, <<http://www.bbc.com/travel/blog/20121213-end-of-the-world-hysteria-boosts-tourism>> (5 January 2013).

Van Stone M., "It's Not the End of the World: What the Ancient Maya Tell us about 2012", 29 July 2008, <<http://www.famsi.org/research/vanstone/2012/index.html>> (20 December 2012).

Walker J., "China School Attack: Officials Say Knife-wielding Man Was Affected by 'Doomsday Rumors'", 17 December 2012, <[http://www.huffingtonpost.com/2012/12/17/china-school-attack-doomsday-rumors\\_n\\_2313876.html](http://www.huffingtonpost.com/2012/12/17/china-school-attack-doomsday-rumors_n_2313876.html)> (4 January 2013).

Walliss J. and J. Aston, 2011, "Doomsday America: The Pessimistic Turn of Post-9/11 Apocalyptic Cinema", *Journal of Religion & Popular Culture* 23 no. 1, pp. 53-64.

White L. M., "Prophetic Belief in the United States: William Miller and the Second Great Awakening", 1999, <<http://www.pbs.org/wgbh/pages/frontline/shows/apocalypse/explanation/amprophesy.html>> (4 January 2013).



Wilson M., "A Wooster Geologist on the 2012 Doomsday Phenomenon", 31 January 2010, <<http://woostergeologists.scotblogs.wooster.edu/2010/01/31/a-wooster-geologist-on-the-2012-doomsday-phenomenon-pseudoscience-baseless-fears-and-the-mysterious-planet-nibiru/>> (20 December 2012).

Xu C., "China Cracks down on 'Doomsday Cult'", 18 December 2012, <<http://www.atimes.com/atimes/China/NL12Ad01.html>> (4 January 2013).

Zhong W., "Doomsday Phobia Hits China", 12 December 2013, <<http://www.atimes.com/atimes/China/NL12Ad01.html>> (2 January 2013).

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