Modern Geocentrism: A Case Study of Pseudoscience in Astronomy

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Abstract

Pseudoscience afflicts all branches of science, but it is particularly popular in astronomy. It is important for students of astronomy to be familiar with the nature of pseudoscience in order to help them identify and avoid it. To this end I present a case study of pseudoscience in astronomy: I analyze the beliefs of the Modern Geocentrists who claim that the Earth is in the center of the universe. I then analyze characteristics shown by the Modern Geocentrists that are common among pseudoscientists. Finally I suggest ways that scientists and science educators can most effectively combat pseudoscience.

1. Introduction

Astronomy is both an ancient and a rapidly growing modern science, and there are many opportunities within astronomy to advance the knowledge of humanity. But astronomy is also a science that attracts practitioners of pseudoscience to question and spread misinformation about the science. It is easier to develop pseudoscience in astronomy than in some other sciences because astronomy often deals with remote objects and distant events. Astronomy is also more likely to attract pseudoscientists because it can deal with some of the very biggest questions, like the origin of the universe and the formation of the Earth, questions that many people have very strong opinions about.

Pseudoscience is to be distinguished from misconceptions about science in that pseudoscience involves a person or group actively advocating for junk science. Misconceptions about science involve a person or group who simply don’t understand or know something about science or who misunderstood part of their education to say something that was not correct. Thus there are people that propose that men never landed on the Moon and the Apollo landings were a hoax: this is pseudoscience. There are also people who believe that Moon phases are caused by the shadow of the Earth or eggs can stand on their ends on the equinoxes: these are misconceptions. Both pseudoscience and misconceptions need to be rooted out and addressed by science education, but in general pseudoscience is active bad science and misconceptions are accidental bad science.

The default reaction of scientists to pseudoscience is to ignore it. Many scientists fear that paying any attention at all to pseudoscience will give it the credibility and notoriety it so desperately desires. But this can mean that science students and the public are left on their own to discern what is real science and what is junk science. Some well-meaning science aficionados may get caught up in the misinformation of a pseudoscience and not understand what is wrong with it. Thus I propose that it is important for scientists and science educators to talk about pseudoscience and to make their students and the public aware of what pseudoscientists are doing wrong. In this way we can help to vaccinate the public against the misinformation and the mis-education that pseudoscientists provide.

I present in this paper an analysis of one small group of astronomical pseudoscientists, the Modern Geocentrists. This group purports to show that Copernicus, Galileo, Einstein and many oth-
ers were in fact wrong in their conclusions and that the Earth is the center of the universe. While the impact of this group may be small, it is a perfect specimen of astronomical pseudoscience. From quote mining to math avoidance to the ever-present conspiracy theories, Modern Geocentrism shows us how pseudoscientists operate. By studying these and other groups and teaching our students about them, we can show our students and the public what not to do and how to recognize pseudoscience.

2. The Properties of Modern Geocentrism

2.1. What is Modern Geocentrism?

Modern geocentrism is the idea that the heliocentric theory developed by Copernicus, Galileo and many others is in fact wrong and the Earth is the center of the universe. It is spearheaded by a man named Robert Sungenis who holds degrees in theology. The major work of Modern Geocentrism is a work about how the Catholic Church was right to condemn Galileo called *Galileo was Wrong, the Church was Right* (1); this tome takes up 1200 pages in 2 volumes. This large book was developed from Sungenis’ 700-page doctoral thesis written on geocentrism at Calamus International University, an unaccredited distance learning institution in the Republic of Vanuatu. There was a conference on geocentrism held in South Bend, Indiana in November of 2010; there were 9 speakers and about 100 attendees. Sungenis recently followed up with a popular science version of his book called *Geocentrism 101* (2). This year he and his group have finished a movie on geocentrism entitled “The Principle”, about the Cosmological Principle, the idea that there are no preferred places or directions in the universe. His production group attempted to get this movie into major theatres, but so far has not succeeded. Modern Geocentrism obtained its 15 minutes of fame when the noted people quoted or involved in “The Principle” found out it was a movie about pseudoscience. This included narrator Kate Mulgrew and scientists Lawrence Krauss and Michio Kaku who were quoted in the film.

Modern Geocentrism is an idea developed by a small group of highly conservative Catholics and religion is an important part of the argument of the Modern Geocentrists (as may be noted in the title of the movement’s primary book). The Modern Geocentrists divide their arguments into religious arguments and scientific arguments. The religious arguments are in general that many passages of the Bible suggest the Sun goes around a stationary Earth and many Popes of the Catholic Church stated that the Earth is in the center of the universe. Considering that most astronomers (and thus most people) thought the Earth was the center of the universe until the 17th century, neither of these things is surprising. I summarize the major scientific arguments in the next section.

2.2. The Basic Premises of Modern Geocentrism

The basic scientific premise of Modern Geocentrism is that the Cosmological Principle is wrong and that there is a preferred place in the universe, the Earth. They suggest that if we throw out the Cosmological Principle, physics will still work, just with the Earth forming the center of the universe. As part of throwing out this principle, though, they also end up throwing out the vast majority of physics, including the standard model of cosmology (ΛCDM), Special and General Relativity, Quantum Mechanics and more. Their position is that Einstein and others were in fact really smart, but they were blinded by their desire that the Earth not be the center of the universe. They propose that these scientists were materialists and didn’t like the religious implications of a geocentric universe. Thus Einstein and others failed to see the right answer because of their innate biases and so pretty much all of modern physics is wrong.

The Modern Geocentrists propose that the reason the Sun rises and sets and the stars rise and set is that the entire universe revolves around the Earth once a day. They indicate that this could be possible if the entire universe were distributed so that the Earth is the center of mass of the universe, perfectly balanced. They present no observational evidence for this, they just try to make the point that it is conceivable that physics could allow this. They imply that because it’s conceivable, it is therefore true.

Sungenis begins his book *Geocentrism 101* with the statement, “Unbeknownst to almost the entire human race is the fact that no one in all of human history has ever proven the Earth moves in space.” This is a first indication that the author doesn’t re-
ally understand how science works; scientists tend to avoid using the word “prove” as they tend to focus more on testing theories and measuring parameters than on proving things. And once something is “proven” it could always be disproven with the emergence of new data; that’s simply how science works. Sungenis then goes through the many different pieces of evidence that indicate the motion of the Earth and attempts to find a reason he doesn’t have to believe the Earth is moving. Of course as philosopher of science Karl Popper tells us, if you don’t want something to be true, you will find a way to interpret the facts to support your belief, which is exactly what the Geocentrist do. For example, the Foucault pendulum changes its direction of oscillation continuously throughout the day due to the rotation of the Earth. Sungenis counters and says that he can achieve the same effect if the entire universe is rotating around the Earth.

Sungenis spends a lot of time on the Michelson-Morley experiment, an experiment which showed no difference in light travel time whether light was going parallel or perpendicular to the motion of the Earth. This experiment was looking for evidence of the medium in which it was believed electromagnetic waves propagated, the lumineferous aether. Since there was no difference in travel time, there was no evidence of aether. Sungenis suggests that this is evidence that the Earth is not moving. He then spends time explaining why Einstein was wrong about the Special and the General Theories of relativity. There is quite a bit of conspiracy theory in these chapters, accusing Einstein, scientists behind GPS and others with hiding the truth. Sungenis also rather blithely claims that lumineferous aether exists, without giving much information on its nature. (In *Galileo was Wrong*, he explains that aether causes gravity.) Sungenis doesn’t spend any time addressing the fact that Special Relativity is critical to much modern technology, including most high energy physics experiments.

Chapter 8 of *Geocentrism 101* begins with the statement, “Ten years after he invented the Special Theory of Relativity to answer the Michelson-Morley experiment, Einstein was force to invent a second theory to compensate for what the first one lacked.” Using words like “invent” implies that Einstein was just making things up randomly. This sentence also betrays a deep lack of understanding of how the development of scientific theories actually works. Sungenis quotes Einstein to say, “The two sentences: ‘the Sun is at rest and the Earth moves,’ or ‘the Sun moves and the Earth is at rest’ would simply mean two different conventions concerning the two different coordinate systems.” In other words, Einstein is saying the question of what is in the center of the universe is not an interesting question. Sungenis, however, uses this quote to suggest that a geocentric universe is possible.

Chapter 9 of *Geocentrism 101* is titled, “The Big Bang: Invented to Suppress Geocentrism.” Sungenis presents Einstein’s “greatest blunder”, the addition of the cosmological constant to the Einstein equation. He then claims, “In any case, adding an arbitrary component to make Einstein’s equation balance with the data demonstrates how easy it was, and still is, to create mathematical equations that give an aura of knowledge and certainty.” Like most pseudoscientists, Sungenis is uncomfortable with math and likes to claim that math lies. He claims next that, “If, as the statistics show, 99.99% of the galaxies are redshifted from our observation point, Earth, it means the universe is geocentric.” This is quite a leap of logic, but one the author makes. He goes on to briefly discuss the Big Bang, but only in a very superficial way and in a way that implies that scientists were sitting around for beers and said, “Hey, why not a Big Bang?” Again, Sungenis has no real conception of how science works and so he suggests scientists make things up ad hoc and conspire to hide evidence about the failings of their theories. At the end of this chapter, the first few verses of Genesis are quoted in large text.

In Chapter 10, Sungenis discusses the cosmic microwave background (CMB). He has already indicated that the Big Bang theory is fake, so it is surprising that he makes no explanation for the origin of the CMB, he simply uses it to prove his arguments. Sungenis describes the CMB experiment called the Cosmic Background Explorer (COBE): “…COBE showed that not only was a significant portion of the universe’s radiation anisotropic and inhomogeneous, but also that it was distributed in well organized pockets or poles that created a specific geometry, all the way from the rim of the known universe to its hub in the
center. Of course COBE’s results did not appear on national news programs but it was very disturbing news for the inner sanctum of the science community.” So here we can see demonstrations of highly non-scientific language (“rim of the known universe”, “hub”) to implications of conspiracy theory to the rare use of the phrase “inner sanctum”. And the implication that anisotropy in the cosmic microwave background made scientists worried is wrongheaded; physicists were more concerned about the absence of anisotropy in the CMB than about its presence. Sungenis goes on to spend a lot of time talking about the “Axis of Evil”, an apparent alignment in the CMB signal with the ecliptic. While he never clearly articulates what exactly is aligned, he suggests that this clearly shows the Earth is in the center of the universe.

The book next looks at dark matter and dark energy, which are again presented as ad hoc inventions scientists thought up to preserve their cherished theories. In the next chapter, Sungenis suggests that galaxies, quasars and gamma ray bursts are all arranged in concentric shells centered on the Earth. To support this, he shows several diagrams showing locations of galaxies. This is a classic example of the use of plots to mislead people. He shows plots of galaxy distribution in the Sloan Digital Sky Survey, and shows how Earth is in the center. Well, of course it is, that’s the point of observation. He does the same thing with a plot of quasars by redshift, showing a void in the center where Earth is. Again, this is what you’d expect, since quasars do not occur at low redshift.

The book closes by looking at results from the Planck CMB probe, and again refers to an observation of “Axis of Evil” to show the Earth is in the center of the universe. Finally it closes with models of how the Sun and the universe revolve around the Earth once each day. It also tries to explain why the Sun moves higher and lower in the sky, causing seasons. The book closes with a quote from the New Testament, applying it to us scientists as, “...those who suppress the truth by their wickedness.”

3. The Properties of Astronomical Pseudoscience as Shown by Modern Geocentrism

3.1. Misunderstanding the Nature of Science

The Modern Geocentrists will frequently point to a controversy or change in scientific theory as evidence of how astronomical science is failing. They do not understand that controversy and change is a sign of healthy science, not an indication of failure. They also frequently ask for absolute “proof” of scientific theories. What this demonstrates is that they do not understand that science does not offer absolute truth, nor does it offer absolute proof, nor can it promise to be unchanging. If science did not change in response to new evidence, it would be very poor at its job. Scientific theories represent our best understanding of the world based on an interpretation of available evidence, but they can always be updated or modified if new evidence comes out.

3.2. Distrusting of Scientists

Pseudoscience practitioners in astronomy tend to suggest that astrophysicists are misled, biased and hiding the truth. Pseudoscience practitioners in medicine (say, the anti-vaccination movement) tend to suggest the same thing about medical doctors and scientists in pharmaceutical companies. The issue at hand is that the experts in the field have spent their lives being trained in their fields and gaining experience in it. Thus the man on the street may not be comfortable with what scientists have to say because he doesn’t have enough education to know why they think as they do and he then is forced to trust their conclusions. If such a person is inclined to distrust scientists, he may fall prey to a pseudoscientific group that offers easy answers about what’s wrong with science and about why scientists are liars. This person then is not likely to have enough knowledge to refute the pseudoscientists and may then believe the narrative of the lying scientists and the small group of rebels trying to spread the truth. The solution to distrust of scientists is education. Not everyone can be an astronomer or a medical doctor or a geologist or a climate scientist, but everyone can be introduced to the major ideas of these fields either in college or through educational reading and
television. Outreach is also important to get the message out about how scientists work and how we’re just like people.

3.3. Motivated by Religion

A large portion of the Geocentrists’ time is spent presenting religious arguments for geocentrism. This is a common factor among many pseudoscientists, that they start with a religious idea and then interpret science to be in accord with their preconceived ideas. This is the issue with the Creationism movement in America. Creationists start with the belief that the Genesis account of creation is literally true, and then reject any science that might contradict this. Ultimately Modern Geocentrists are just a special kind of Creationist, and their motivations and methods are very similar. In fact there have been efforts to establish alliances between Creationists and Geocentrists.

The Modern Geocentrists are composed of highly conservative Catholics that dislike the changes in the Catholic Church since the 1960s. They believe that these changes ultimately originated in the scientific revolution, which was initiated by Copernicus, Galileo and others. Of course Galileo proposed arguments for Copernicus’ idea that the Earth orbits the Sun and was subsequently condemned for these arguments by the Roman Inquisition of the Catholic Church. Eventually it was shown that Galileo was right and that the Church made a mistake in this situation. The Geocentrists feel that this admission of error in condemning Galileo changed the paradigm of relations between religion and science, leading to a liberal, permissive Church and a form of science that attempts to dominate everything. Thus they believe that the only way to fight what they see as liberalism is to say that the Church was right in condemning Galileo.

This is not to say religion and science are incompatible; in fact many scientists are both religious and highly skillful at science. The problem that leads to pseudoscience is starting with a postulate based on religion and rejecting any scientific conclusions that contradict the postulate. Thus the problem is not one of religion, it is a problem of approaching science with preconceived notions about what the answer ought to be. If you a priori are convinced about something that affects science, you will interpret your science to make it agree with your beliefs. In other words, if you want something to be true, you will find ways to make it seem true. Karl Popper talks about this problem explicitly by referring to followers of theories of Marx, Freud and Adler:

I found that those of my friends who were admirers of Marx, Freud, and Adler, were impressed by a number of points common to these theories, and especially by their apparent explanatory power. These theories appear to be able to explain practically everything that happened within the fields to which they referred. The study of any of them seemed to have the effect of an intellectual conversion or revelation, open your eyes to a new truth hidden from those not yet initiated. Once your eyes were thus opened you saw confirmed instances everywhere: the world was full of verifications of the theory. Whatever happened always confirmed it. Thus its truth appeared manifest; and unbelievers were clearly people who did not want to see the manifest truth; who refuse to see it, either because it was against their class interest, or because of their repressions which were still “un-analyzed” and crying aloud for treatment. (3)

3.4. Make Use of Quote Mining

Modern Geocentrists spend a large amount of effort on quote mining, that is taking a quotation out of context to show that writer believes something he or she did not in fact believe. Both of the Geocentrist writings referenced above are primarily lists of quotations from famous scientists. Thus on page 12 of Geocentrism 101, the author quotes Stephen Hawking in The Grand Design as saying, “So which is real, the Ptolemaic or the Copernican system? Although it is not uncommon for people to say that Copernicus proved Ptolemy wrong, that is not true. As in the case of our normal view versus that of the goldfish, one can use either picture as a model of the universe, for our observations of the heavens can be explained by assuming either the earth or the sun to be at rest.” Sungenis uses this to show that this is a scientist admitting that the Earth could be in the
center of the universe. But that’s not what Hawking was saying at all; rather, he was making a point that there is no “one true model” of the universe.

3.5. Make Use of Conspiracy Theory

At the first annual conference (it was the only annual conference) on geocentrism held in November of 2010, the first talk was entitled: “Geocentrism: They Know It But They’re Hiding It.” One of the major themes of Modern Geocentrism is that there is a conspiracy of physicists to hide the truth from humanity that the Earth is in the center of the universe. One hears this claim a great deal from pseudoscientists around the world. It might be a free energy machine that utility companies don’t want known or it might be the dangers of vaccinations that medical doctors and drug companies want hidden or it might be the “fabrication” of the Moon landings that the government wants hidden. The reason that conspiracy theory is so prevalent in pseudoscience is there is always a pressing question: If this idea is so good, why don’t physics professors, or medical doctors, or energy companies talk about this? The fig leaf used to cover this hole in the pseudoscience is conspiracy theory. Conspiracy theories are not only useful new garments for the emperor, they are also absolutely not demonstrable because they are secret and undocumented by definition.

Astronomical conspiracy theories (including those supported by the Modern Geocentrists) frequently target NASA. This is likely because NASA is the most public face of space science and technology in America. Targeting NASA as the face of American astronomy, however, shows a naivete about the nature of astrophysics. While NASA does conduct astronomy research, much more such research is done at American universities and national labs than at NASA.

3.6. Singlehandedly Overthrowing the Scientific Paradigm

The Introduction to Geocentrism 101 ends with these modest words: “The evidence you are about to see is so shocking and so revolutionary that once you grasp its significance your whole view of life will be instantly changed. Life itself, and the reason for our existence, will become crystal clear.” Typically when scientists write a paper or a book, they purport to increase the knowledge of humanity by a little bit, to make a small contribution to the advancement of understanding. Typically when pseudoscientists write a paper or a book, they purport to completely change science as we know it. Thus an important way of telling science from pseudoscience is the level of modesty of the authors. Are they trying to stand on the shoulders of giants that have come before, as Newton did? Or are they trying to overthrow science or technology or medicine as we know it?

3.7. Allergic to Math

In one of his most famous quotations, Galileo reminds us that, “Philosophy is written in this grand book, the universe, which stands continually open to our gaze, but it cannot be understood unless one first learns to comprehend the language and interpret the characters in which it is written. It is written in the language of mathematics, and its characters are triangles, circles, and other geometrical figures, without which it is humanly impossible to understand a single word of it; without these, one is wandering around in a dark labyrinth.” Thus another way to tell good science from junk science is to see if there is a mathematical basis for the science. Science is by its very nature mathematical; for this reason scientific theories are able to predict both how and how much. Early astronomy was very much a study of geometry. Modern astronomy remains very much based on geometry, but also makes use of algebra, calculus, differential equations, linear algebra and much more. But clearly to make sense of theories in astrophysics, one must first receive some training in mathematics.

Pseudoscientists on the other hand prefer to avoid math, typically because they lack any significant training in mathematics. Pseudoscientific tracts will often have a distinct dearth of mathematical equations or discussions. Writings from the Geocentrists are certainly this way. In Geocentrism 101 there are only a few equations stated and the explanation of them is either minimal or non-existent. For example, on page 157 of this text, Friedmann’s equations are presented, but the variables are not defined and their use is not explained. Galileo Was Wrong has a bit more math, but math is still used sporadically and rarely. On the other hand, papers and books presenting as-
trophysics will contain equations and discussions of those equations throughout. In my interactions with Geocentrists, I have brought up the lack of math; their response was that scientists are trying to hide the truth behind all that math and that real physics can be understood without all the obfuscation of mathematics. I will let Mr. Galileo handle that one.

3.8. Don’t Understand Scientific Discourse

This section builds on Section 3.7, another way to tell real science from junk science is that purveyors of junk science typically don’t understand scientific discourse. That is, to quote the opening scene of The Music Man, “He doesn’t know the territory!” Pseudoscientists don’t know the process of submitting papers to journal for peer review, they don’t understand the importance of scientific collaborations and they don’t understand typical scientific language. Rather pseudoscientists almost invariably go straight to the people, self-publishing books and hosting websites. Thus both of the Geocentrist books I discuss here were self-published by Robert Sungenis’ organization called Catholic Apologetics International. The very length of Galileo Was Wrong indicates that Sungenis does not understand the lexicon of science. Most graduate students who present a 700 page dissertation would be sent back to cut out about 500 pages. Both Galileo Was Wrong and Geocentrism 101 follow a pattern of presenting major scientists as authority figures and presenting major quotes from them to prove a point. This is not something scientific writing normally does; rather arguing from the authority of major figures is something more common to theology than to science. This is not surprising given Sungenis’ training as a theologian.

4. How to Fight Pseudoscience

4.1. Educate

A discussion of both the nature of science and the nature of pseudoscience ought to be part of every general education science class in college. High school science teachers should bring it up. Too often students of science have memorized the “5 steps of the scientific method” without really understanding what the scientific method is or what a scientific theory is. In my own general education astronomy classes I spend the first week of the class on the definition of science and examples of pseudoscience. We would first discuss what science is and how science works. We would read an excerpt from Karl Popper on his approach to the demarcation problem between real science and non-science. Then we would bring out ideas like ancient aliens, Moon landing denialism, young-Earth creationism and more to try to understand why they are not science. If every high school and college student in America encountered this kind of a discussion, there would be far fewer people who would fall prey to pseudoscientific ideas.

Pseudoscience frequently offers a teachable moment. In the case of Modern Geocentrism, this is a chance to teach about how we know the Earth orbits the Sun, about what exoplanets are, about seminal astronomers like Aristarchus, Ptolemy, Copernicus, Galileo and others, about Special Relativity and more. In the case of moon landing denialism, we can bring up the history of the space program, the engineering of the Moon missions, photographs taken by the Lunar Reconnaissance Orbiter and more. And learning about pseudoscience itself is an interesting exercise in things like psychology, sociology, history and much more. Finally being able to discern if something is real science or pseudoscience is an excellent exercise in critical thinking. Deciding whether something is real or pseudo-science is an use of evaluation, which is the highest of the cognitive tasks in Bloom’s taxonomy.

Scientists who participate in outreach should be prepared to deal with pseudoscience. Chances are low that they will encounter a Geocentrist, but chances are high that they will encounter a Creationist or someone opposed to the theory of evolution or some other person uncomfortable with some element of modern science. Speakers and educators need to be ready with what to say when someone in the audience shouts, “But that’s only a theory!” This is now a teachable moment! “Ah, but what is a scientific theory? It’s not a guess, it is the final product of science. This is how science works...”

Finally we ought to be educated about the modus operandi of pseudoscience in case we encounter it in public life. Perhaps there is a discussion in a school board meeting about whether to buy textbooks that present young-Earth creation-
ism. Perhaps there is a comment in a town hall meeting that climate change is fake and made up by scientists. Perhaps there is a debate about whether vaccinations should be encouraged in America. Understanding the m.o. of pseudoscience will prepare scientists and science educators for encounters with such things and will help us to educate the citizens.

4.2. Don’t Debate

Debating pseudoscientists directly is not useful and it may often be harmful. Purveyors of pseudoscience are frequently very effective at communicating their idea in a very biased way to the general public. In a scientific forum, they wouldn’t last a minute because the audience would see exactly what is wrong with their arguments. But in a general audience, fewer people have the experience and knowledge to identify the problems with the arguments. Pseudoscientists will use this fact to buoy up their own case while presenting the real science in a very biased and incorrect way.

Purveyors of pseudoscience will also frequently bring up very obscure arguments that have no real value but which they will use to show their intellectual superiority. For example a Modern Geocentrist might say, “Yes, that’s fine, but what about the experiment performed in August of 1922? What about what it says on page 3?” Your average scientist will not have such specifics in his mind for immediate use, and if she admits that she doesn’t know, the pseudoscientist can then use this to prove her ignorance.

It seems as though the good ought to win out in every contest between science and pseudoscience and exposure to real science ought to be enough to win over the crowd. Unfortunately it doesn’t work that way, and sometimes a debate will be won by someone who is very wrong but has more experience packaging the information for the audience or manipulating a friendly audience against the scientist who represents “The Establishment”.

Finally, debate implies a conflict of peers. Pseudoscientists like to present the image that there is a major debate within science about their chosen topic. For example, young-Earth Creationists try very hard to suggest that there is a real debate in science about whether the Earth is 6000 year old. Likewise all pseudoscientists want to present their case not as a crank trying to break into real science but as a major debate within science. This isn’t true, and we should let them get away with misinformed the public. So we should not debate pseudoscientists as this would give them credibility they do not deserve. But we still ought to talk about the pseudoscience: If medical doctors cover the hospital with “Wash your hands!” signs to make people aware of germs, we scientists ought to cover the halls with “Watch for junk science!” signs to make people aware of bad information. At least we can make metaphorical signs in our teaching and outreach.

5. Conclusion

Pseudoscience remains popular in all areas of science and there are many people who believe in at least one type of pseudoscience. I propose that ignoring pseudoscience is ineffective and only encourages it to spread. Rather scientists and science educators ought to seize pseudoscience as an opportunity to teach about how science works and what is wrong with pseudoscience. I present a case study of one specific pseudoscience in astronomy, Modern Geocentrism. I discuss the works created by the Geocentrists and I present their basic philosophy and ideas. I then use these to identify some of the major traits of pseudoscientists. These include: (1) misunderstanding the nature of science; (2) distrust of scientists; (3) religious motivation; (4) quote mining; (5) conspiracy theory; (6) attempts to singlehandedly overthrow science; (7) avoidance of math; and (8) lack of understanding of scientific discourse.

Finally I suggest what actions scientists and science educators should take against pseudoscience. First, we ought to discuss pseudoscience in science classes as it offers teachable moments and high-level cognitive analyses for science students. Next we ought to be prepared to address pseudoscience in public talks and outreach. We also should be prepared to discuss pseudoscience in public meetings and policy discussions. Finally we should avoid debating pseudoscientists directly.

In conclusion, let’s not ignore pseudoscience, rather let’s discuss it and use it to teach and educate people about how to tell the difference between real and junk science!
REFERENCES

[1] Robert Sungenis and Robert Bennett, *Galileo was Wrong, the Church was Right, 10th Edition*. Catholic Apologetics International, 2014.


