God Under the Dome

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As an astronomer and Jesuit, wearing both a Roman Collar and an MIT Class Ring, I am living proof that it is possible to be at the same time a fanatic and a nerd. I am both; I am a fanatic about my science, and a nerd when it comes to delighting in the workings of my religion.

The supposed conflict between science and religion is an issue that affects all of us whose job it is to present science to the general public. In planetariums, you are on the front line of this great educational program; and as such, you have undoubtedly encountered the sincere patron who firmly holds that the billions of years and millions of light years you talk about in your shows are a threat to their faith. You may well have asked yourself, "How can I talk to these Fundamentalists?" I don't claim to have all the answers, and I am sure that you all have stories to match any that I will be bringing here. I don't consider this article to be a definitive answer in any way. Rather, I hope that it might serve to start the conversation among ourselves.

I. Know Your History

In reflecting about how we deal with God under the Dome, I am personally inspired by the motto of my own Observatory, inscribed on a telescope dome located at the Pope's summer home in Castel Gandolfo: "Deum Creatorem, Venite Adoremus." Even if your memory of high school Latin is nonexistent, you should probably be able to guess what it means. "Deum" — God — is the word that English gets "deity" from. The word "Creatorem" — the creator — is essentially unchanged in English. Anyone familiar with Christmas carols will recognize the next two words, "Venite Adoremus", come, let us adore him. "Come, let us adore God the Creator."

If a person of faith accepts God as Creator of the universe, how can they possibly find fault in the scientific enterprise? How better to get to know the Creator than by studying the things that have been created? (And on this issue I quote no less an authority than St. Paul, in his letter to the Romans, Chapter 1, verse 22.)

Indeed, the roots of science and religion are much closer than many people realize. If in the past the two have squabbled, it's a sibling rivalry: science has its beginnings in the medieval scholastic theology that attempted to understand God using the tools of reason and philosophy. Recall, astronomy was one of the seven subjects you were expected to master in the medieval universities before you could go on to study theology or philosophy.

The "fathers" of many fields of science were monks or priests. Saint Albert the Great, a Doctor of the Church who was Thomas Aquinas's teacher, wrote the first systematic book of mineralogy. Roger Bacon, the father of Chemistry; Christopher Clavius, the "Second Euclid" of the Renaissance; Gregor Mendel, the father of genetics, were all priests or monks.

The Vatican Observatory itself traces its origins back to the 16th century and the Council of Trent, which instructed the Pope to hire an astronomer and other experts to reform the calendar. Fr. Christopher Clavius, the Jesuit astronomer and mathematician, played a key role in devising what we now know and use as the Gregorian Calendar, promulgated by Pope Gregory XIII in 1582.

(Incidentally, the astronomers working out that calendar reform used the tables and calculations published forty years earlier by Copernicus in this work. They eventually decided that the date of Easter, a key sticking point, would be determined by an arbitrary formula, not by the position of the Moon — unlike Passover or Ramadan — so that we'll have no problem deciding when to hunt for chocolate eggs when we move to Mars!)

Indeed, when Copernicus published his revolutionary work, he did so at the urging of a Cardinal, and he dedicated the book to the Pope. It was accepted without serious problem in the Catholic world for nearly eighty years, before Galileo got in trouble.

Presenting astronomy to the general public inevitably involves one in the ongoing discussion of science and religion; in particular, one is likely to encounter members of the public who fear that their strongly-held religious views are disrespected or attacked by modern science. To deal appropriately with such attitudes, it is important to know the history of the relationship between science and religion; to understand the source of anxiety among those in the public who are mistrustful of science; and to be aware of one's own attitudes towards religion and how these may unintentionally color the way we present our material. A brief survey of the history of astronomy shows that there is no inherent conflict, and much commonality, between science and religion. However, people unfamiliar with science often fear it as a substitute or threat to their beliefs, a fear that is compounded when science is presented in a way that does not respect its philosophical and religious roots. One successful strategy is to present astronomy within a religious context, even to the point of discussing one's own religious affiliation, and always emphasizing the humility that comes with admitting that one's knowledge is ever incomplete.

Based on an invited talk at the 2003 Great Lakes Planetarium Association conference. Reprinted with permission from the Proceedings of the 39th Annual GLPA Conference."

But what about Galileo? I could spend an hour talking about Galileo. Since he is usually held up as a prime example of how the Church and Science have been opposed, it's worthwhile to spend a minute or two remembering a few key points that get overlooked in the usual telling of the Galileo Myth.

First of all, Galileo was a devout Catholic. He remained so even after his trial in 1632. His two daughters were both nuns. (Granted, he never married their mother; he was an Italian Catholic, after all!)

He could have fled Italy for the Protestant north at any time; he chose not to. He had submitted his books to the appropriate government and church censors (all governments in those days censored books; the idea of a "free press" was still hundreds of years in the future) and he'd never had any serious trouble passing review.

For most of his life Galileo was lionized in Rome. Indeed, the approval that the Church censor wrote for an earlier book, The Assayer, is so fulsome that it reads like the kind of blurb you'd expect to see on a Tom Clancy novel: "I believe our age is to be glorified by future ages.... thanks to the deep and sound reflections of this author in whose time I count myself fortunate to be born ...."

Even the book that eventually got him into trouble, A Dialogue Concerning the Two Chief Systems of the World, was originally passed by Church censors. Perhaps more oddly and more telling, immediately after his trial and famous "abjuration" when he was confined to house arrest, he first served that "arrest" in the house of the Cardinal of Siena. He was considered an honored guest and treated so well that his enemies complained and forced him to return to his estates in Florence.

It was in Florence, after the trial, where he finally finished his most important work, Discourses and Mathematical Demonstrations Concerning the Two New Sciences. (To avoid any more headaches with the local censors, this book was published in Holland—a route he could well have chosen for his earlier works if he had really thought they were going to lead to trouble.)

That trouble brings up a second important point to remember about Galileo. He was never convicted of heresy.

Indeed, if you read the transcript of his trial (it, and many other relevant documents, are available in English translation in a book edited by M. A. Finocchiaro, The Galileo Affair; U of California Press, 1989) you see that the entire argument was over a technicality. If you are looking for a long philosophical discussion of science versus religion, you won't find it here.

At the end of the trial, the sentence was promulgated and it appears to have nothing to do with the trial itself, as if it had already been written before the trial began. It did originally call Galileo a heretic, but Galileo argued that he wasn't, and that his "heresy" had never been shown. The judges agreed. Instead, the final version of the sentence condemns Galileo on the grounds that he has been "vehemently suspected of heresy" which is hardly the same thing, and indeed a peculiar sort of a crime!

Even in the famous abjuration, Galileo only renounces "anything in my writings which goes contrary to the faith" — which is to say, he abjured nothing, since he believed that nothing he said was heresy. He was right.

That's the third, and perhaps most important thing, to remember. Galileo was right. The Church was wrong. And the Church has said so, in many times and many ways over the years that followed.

We must remember what the Church actually did that was wrong. It was not necessarily wrong philosophically, or even technically. (Galileo was indeed guilty of the technicality of violating an agreement he'd entered into twenty years earlier not to agitate for the Copernican system during those turbulent times.) What the Church did wrong was to confuse its religious role of defending the faith, with the secular role it played as the only functioning government in the central part of Italy and as such a world power wrapped up in the politics of its day.

It is important to remember that the Galileo trial occurred in the middle of the Thirty Years War, that terrible conflict pitting half of Europe against the other half. That war is usually portrayed as a war of religions, but if you look more closely you see that it looks much more like a war of Spain (which also controlled the Holy Roman Empire) against those nations who feared Spanish dominance on the continent of Europe.

Spain's enemies included both the Protestant parts of Germany and Scandinavia, and Catholic France. The Italian states were leery themselves of Spain and many, including Galileo's Florence, secretly supported France. Was the Galileo trial brought about by Spanish pressure on the Pope, as a way to put pressure on the Medici family of Florence? If so, it would have virtually nothing to do with science or religion.

I am not a historian. I note that there are as many different theories (and books) about what caused Galileo to go on trial as there are people who've looked into the matter. If nothing else, that convinces me that the motivations behind the Galileo trial, whatever they were, were not merely a blunt attack of the Church on Science.

One often reads that following the trial, all science stopped in Catholic Europe and only continued in the Protestant north, like England or Germany. (Oddly, the people who say this tend themselves to come from England and Germany.) A cursory glance at the history of astronomy shows otherwise.

Twenty years after the Galileo trial, the Italian/French astronomer Cassini — with Church cooperation — turned the cathedral of Bologna into a giant "camera obscura" to trace the size and position of the Sun's image on the cathedral floor. His goal was both to measure precisely the latitude of the cathedral (as done eventually in many Catholic Cathedrals, to provide the fixed points from which the first accurate maps of Italy and France were drawn) and to measure how the size of the Sun changed during the year, which would be a test of Kepler's theories. (For more details, see J. L. Heilbron's book The Sun in the Church, Harvard University Press 1999.) Cassini went on to found the Paris Observatory, accurately describe the rings of Saturn, and discover Saturn's moon Titan.

The modern naming of the craters of the Moon dates from a map made in Italy in

The great astronomer appeared on the Italian 2000 lira note some years ago.

1672, forty years after Galileo's trial. There are thirty-five Jesuit priests whose names have been given to lunar features, no surprise, since it was a Jesuit, G. B. Riccioli, who made the map. Incidentally, among the most prominent craters on the Moon are those named for Clavius (remember the Moon Base in the movie 2001, A Space Odyssey) and for Tycho Brahe, the last defender of the geocentric system. However, the most central, most prominent crater on the Moon Fr. Riccioli gave the name "Copernicus."

Riccioli's map is based on many observations by another Jesuit priest, F. Grimaldi, who was the first person to describe diffraction in terms of a wave theory for light. Other Jesuit scientists of the era were those who took modern scientific instruments to the Imperial Court in China, using western science as a demonstration of the superiority of western thought.

So much for the Church trying to stamp out scientific thought.

Indeed, many people seem to misunderstand just how "monolithic" the Catholic Church is. This is, after all, the Roman Catholic Church we're talking about; to get a feel about how seriously they take rules and regulations, just try driving in Rome!

As an example: after Galileo's agitation in 1616, the Roman censors ordered that all copies of Copernicus' book be edited — not burned, merely edited — so that a line was crossed out and a few words added to the effect that the Copernican system was merely a calculating device, not a real description of the heavens. Yet, recently Owen Gingerich, the Harvard historian of science, did an examination of all the extant copies of Copernicus and he found that only half the copies in Italy were so edited; and virtually none of them outside of Italy were changed in any way!

Though I have concentrated up to now on science done in Catholic Europe, it is worth noting that the scientists of the Protestant half of Europe also considered themselves to be devoutly religious men. Kepler, Newton, and Leibnitz all thought of themselves as theologians and philosophers as well as scientists. Indeed, the majority of scientists up until the mid 19th century, not just the big names, but also the tireless workers who gathered and classified flora and fauna, observed double stars, and so forth, were by and large clergymen. Who else had the education, and the free time, to pursue scientific work? Recall that the English word "clerk" is simply a shortened form of "cleric" and we still refer to such classification, filing and sorting, as "clerical" work.

One of those clergymen was the young Jeremiah Horrocks, the first to see a transit of Venus. One hundred years later, in the 1700s expeditions to observe the transit, Jesuit astronomers played a large role. How could they not, considering that 30 of the 130 observatories in Europe — nearly a quarter — were run by Jesuits? Along with Jesuit astronomers in China, India, and Africa, the expedition of Fr. Maximillian Hell into Lapland was notable, especially considering that it was only by special invitation of the King of Denmark that he could enter Scandinavia, where Jesuits were considered so dangerous that they were forbidden to set foot in the country. (Such laws in Scandinavia and Switzerland stayed on the books well into the middle of the 20th century.)

Alas, Fr. Hell soon fell prey to the anticlerical movements of Europe that eventually led to the suppression of the Jesuit order for 45 years, and the beginning of the myth of the split between science and religion. In Europe, the anti-religious fervor of the French Republicans saw the Church as supporters of the old kings and thus enemies of their sense of the "progress of man". In the United States, anti-Catholic nativism sometimes took the form of books like Andrew White's The Warfare of Science with Theology, which argued that all progress in science occurred in spite of religion, while all opposition to progress was rooted in the "superstitions" typical of the newly arrived, and poorly educated, immigrants from southern and eastern Europe.

Fr. Hell's private hell came in the guise of accusations by the French revolutionary Jerome Lalande that his excellent transit observations were suspiciously "too good" and thus must have been faked. Hell's reputation was further slandered by J. J. Littrow, the Director of the Vienna observatory in the mid 1800s, who based his attack in part on the perceived difference in colors of the inks Hell used to record his measurements. It was only in 1890 that a review of the affair by Simon Newcombe completely exonerated Hell — noting, among other things, that Littrow himself was color-blind!

It was in this anti-clerical atmosphere that Pope Leo XIII in 1891 decided to use the resources of the Vatican to formally found a Vatican Observatory, "that everyone might see clearly that the Church and her Pastors are not opposed to true and solid science, whether human or divine, but that they embrace it, encourage it, and promote it with the fullest possible devotion."

There were several reasons why astronomy in particular was chosen for this role. For one thing, national observatories were a well-accepted sign of nationhood, an important political issue at a time when the Vatican was still fighting to be recognized as independent of the anticlerical Italian kingdom. The tradition of astronomy supported by the Vatican, going back to the calendar reform, was undoubtedly another argument in its favor; and perhaps, it also served as a direct counter to the Galileo affair.

No doubt a large reason was the already strong reputation in astronomy that the Papal States had accrued thanks to the work of Fr. Angelo Secchi. Building a set of telescopes atop the church of St. Ignatius (on pillars designed to bear the weight of a dome that was never built), he had observed Mars at close approach and suggested the presence of "canali" to his friend G. Schiaparelli. More importantly, he was the first astronomer to

The Tower of the Winds, built in 1582 at the time of the Gregorian Calendar Reform, housed the re-established Specola Vaticana (Vatican Observatory) in the late 1890s. Note the telescope dome on the roof. From "In the Service of Nine Popes" by Fr. Sabino Maffeo (2002, University of Notre Dame Press).

pass starlight through a prism and thus classify stars by their chemical composition. For changing astronomy from the study of stellar positions, to the study of stellar physical states as revealed in their spectra, Fr. Secchi is often called the Father of Astrophysics.

Since 1891, the Popes have supported the Observatory both financially and with their personal presence. Pope Pius XII was a keen amateur astronomer. On July 20, 1969, Pope Paul VI spoke to the astronauts on the Moon from the dome of the Vatican Observatory's Schmidt telescope. Pope John Paul II has issued landmark documents on the complementary role of science and religion, in consultation with both Vatican Observatory astronomers and his friends in the Polish astronomical community, such as the astronomer/cosmologists Michael Heller, who is a priest, and Joseph Zycinski, who was named archbishop of Lublin by the Pope in 1997.

Among the many notable achievements of the Observatory (including the collection of one of the world's largest set of meteorites, my specialty) was the spectrochemical laboratory of the 1930s and the building of the Vatican Advanced Technology Telescope on Mt. Graham, Arizona, serving as the testbed for technologies now going into the Large Binocular Telescope currently under construction.

Among the more ironic of these achievements was the 1910 experiment by Fr. J. G. Hagen using carefully balanced weights to measure the coriolis force due to the Earth's spin. After the Foucault Pendulum, this was only the second proof of the Earth's spin; thus Jesuits at the Vatican proved Copernicus was right! (For many more details of the Vatican Observatory's history, see Sabino Maffeo's book In the Service of Nine Popes, University of Notre Dame Press, 2002)

The point of all this history is that there is no historical foundation for the idea that science and religion are eternally opposed. It also follows that there is no reason to believe that you "have to be an atheist" to be an astronomer or a scientist.

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Indeed, most modern physicists are, like Einstein, at the very least "theists" believing in some sort of God. Some of the biggest names in modern physics were active participants in religions, Protestant or Catholic. Among them one can list James Clerk Maxwell (Anglican), Guglielmo Marconi (Catholic), and Erwin Schrödinger (Catholic).

The first person to propose what would come to be called the Big Bang theory was a Belgian priest, Abbe Georges LeMaître. (There is a wonderful photograph of him standing between Albert Einstein and Robert Millikan.) Modern astronomers who are public with their religious affiliations include the discoverer of pulsars, Jocelyn Bell-Burnell (Quaker), and the Apollo 11 astronaut Buzz Aldrin, who brought Presbyterian communion elements of bread and wine to the Moon.

Indeed, when I became a Jesuit brother after fifteen years in the field of planetary sciences, I was surprised how many of my scientific colleagues suddenly felt free to talk to me about their own churches. From this experience I would guess that the proportion of those working in astronomy who are also churchgoers is no different from the general population at large.

This connection shouldn't be surprising. After all, western religion provides the essential underpinnings for two fundamental assumptions on which all science is based.

First, if you're going to do science, you have to believe that science is worth doing. Is pure knowledge about the physical universe in and of itself a worthy pursuit for one's life? If your philosophy or religion maintains that the physical world is a trap or an illusion, then even pursuing knowledge for the sake of curing disease (or getting rich by building better mousetraps) will be seen as inferior to the more "spiritual" goals of, say, reaching Nirvana through meditation. That attitude certainly did nothing to promote the study of the natural world in India or China.

However, the Jewish, or Christian, or Islamic belief in a creator God, one who at the end of the day looks at His handiwork and declares it "good," implies that the physical universe has also a spiritual worth. The peculiarly Christian doctrine of the Incarnation suggests that (to quote the ancient Church father St. Athanatius) the physical universe has been "cleansed and quickened" by the physical presence of the Divine in its midst. The Gospel of John (in the verse made famous at countless football games, John 3:16) notes that God sent his Son because he "so loved the world" — not humanity, or goodness, but the world.

Second, to apply the powers of observation and reason to the physical universe, you must start with the assumption that the physical universe is itself reasonable. If you believe the universe is merely random chaos, again as was seen in the ancient East, then there is no hope in imposing reason upon what is eminently unreasonable. If that were true, than science would be no more valid than finding faces in the clouds. The Genesis story of the seven days of creation tells the

In the 1930s a spectrochemical laboratory was established at the Specola Vaticana in Castel Gandolfo. Today the room houses the Vatican's meteorite collection, one of the largest in the world. From "In the Service of Nine Popes" by Fr. Sabino Maffeo (2002, University of Notre Dame Press).

believer that God made the Universe according to a logic and plan that is ours to discover.

II. Know Your Opposition

If religion is not only not opposed to science, but provides the essential underpinnings to science, then why are so many religious people opposed to science? One way to find out is to ask them, and listen to their answers.

In the issue of Science News for June 8, 1996, Janet Raloff's article "When Science and Beliefs Collide" summarized much of the research that had been done on the attitudes of those in our culture who were seen to be opposed to science.

She noted that many people misunderstand the basic precepts of science, and these misconceptions about science could be traced to the deeply held ways, the "belief systems," through which an individual interprets the world. Fundamentalists interpret the world in light of what they learn from authority (e.g. the appropriate Bible verse) as opposed to forming and testing hypotheses like the classic "scientific method" teaches. Radical thinkers among minorities or feminists have a basic distrust of science, which they see as an expression of white male dominance in Western society. In addition, Postmodernist philosophers, questioning the assumption that the physical universe can ever really be known, were prone to dismiss science as merely a "useful myth."

Each of these statements reminds me of a principle I learned in theology: "Every heresy is based on an important truth." While I would disagree with the ultimate conclusions of Fundamentalists, Radicals, or Postmodernists, I have to concede that in each case their premise is based on an important truth.

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All of us, especially scientists, interpret the world in light of what we have learned from authority. I can't do every experiment or measure every physical constant; I must trust the literature, including the professors who taught me. We believe the world is round for the same reason a Fundamentalist believes God made it; because someone we trust told us so.

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If you don't think that science to this day is still dominated by white males (I confess to be guilty of being one myself) simply look around the room at the faces present at the Great Lakes Planetarium Association annual meeting. It's better than it used to be; but we still do not accurately reflect the population as a whole.

Even the Postmodernists have a point. Everything we do in science is colored by the fact that we are human beings in a community of humans. The questions we ask, and the way we apprehend their answers, are all strongly influenced by our own personal urges and by the influences of the society in which we live (and what that society chooses to pay for). Among other things, this means that "truths", which come to us from outside the context of our contemporary society will be misunderstood and unappreciated. Just as we depend on authority, so we depend on our ability to recognize who gets to speak with authority.

Raloff's Science News article goes on to describe the results of polling two specific groups that were thought to be hostile to science: religious Creationists and New Age Pagans or Wiccans. The surveys found that many of those polled were very well educated; that rather than being just a manifestation of a certain brand of evangelical Christianity, Creationism cuts across denominational and social class lines, and in fact the Wiccans and Pagans expressed somewhat more antiscientific attitudes than Creationists, for instance in being far more likely to accept astrology and reject "scientific" arguments against it.

Not surprisingly, 80 percent of the Creationists surveyed believed that Earth is not 4 billion years old. More than 60 percent of Wiccan/pagans shared this view. (Perhaps more surprising is that a significant percentage of each group had no problem with the concept.) About a quarter of both groups thought science causes spiritual decline, while roughly 40 percent of each said scientists possess dangerous powers.

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Again, we must recognize that to some degree, these fears are not totally unjustified. I spent two years in the Peace Corps, living in the third world. I saw first hand that people who lived "close to nature" lived much of

The Vatican Advanced Technology Telescope, the world's first large spin-cast mirror (1.8 meters) located at the Mount Graham International Observatory in Arizona. Photo courtesy Christopher Corbally SJ.

The dome of the 60 cm (24 inch) Double Astrograph telescope at the Vatican Observatory's headquarters in Castel Gandolfo. Note the plaque reading "Deum Creatorem Venite Adoremus": Come let us adore God the Creator." (courtesy the author)

their too-short lives cold, hungry, and vulnerable to disease. However, I would have to be blind to ignore the fact that the same technology that feeds and warms us, also pollutes our streams and atmosphere; that the science that explains how stars work, also suggests how weapons of mass destruction can work.

I think most scientists are humble enough to recognize the limitations and dangers of science (though I worry about some of my friends in genetics). However, it may well be that most non-scientists don't see any sign of such humility in the way we present our science to them.

The point is that the issues, indeed the fears, of the Fundamentalists are not tied to any particular bit of science, but rather to the more general perceived attitude that science is opposed to religion. Given the premise of a fight between the two, people who are comfortable with their religion, but uncertain of science will always choose what they already know. So we can conclude that many of these people might accept the explanations offered by science if they felt that doing so wouldn't subsume their religion.

In dealing with Fundamentalists, we must recognize some important dynamics of how their beliefs differ from what we would call scientific arguments. First, recognize that "Creationism" — saying that one accepts the "literal truth of Genesis" — is a litmus test for membership in some sects. This attitude is a sense that "By fighting evolution, we're saving souls." Thus any attempt to argue directly against Creationism will be immediately interpreted as an attack on their religion, and an attempt to stop souls from being saved.

However, it is not clear just what they mean by a "literal truth." Certainly I have never heard a Creationist insist that the world is flat, with a dome above it separating the world from the "waters" above and below, even though that is literally what is found in Genesis. (And it's not a bad description of a planetarium!)

If you dig more deeply into what they really mean by "Creationism" you will soon realize that it is not a scientific principle that they are holding to at all. For example, the survey found that many people who "reject evolution" can accept the idea that there are thousands of planets in the universe on which life might have developed. More oddly to us, even while they insist the world is only five thousand years old, some of them may also agree that the continents on which we live have been moving in their locations for millions of years.

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The lesson for us should be clear. Science is not religion; it must not be portrayed as such. All the more reason that we should be cautious of sounding like the Voice of God coming from the dome.

III. Know Yourself

When I was an MIT student, I once was in conversation with a fellow in class where it came out that, in fact, I did go to church on Sunday. He was astonished, and wanted to talk to me about it. It happened that he had come from West Virginia, raised by strict Baptists, and his experience of religion was very different from mine. Coming to the Big City had been a real eye-opener to him, and he viewed his old religion as a collection of constricting falsehoods that fell to pieces once he had a taste of the Real World.

I in turn was fascinated by his attitude, since that wasn't my experience of religion at all. So I asked him, what in particular had religion lied to him about?

"They told me all sorts of crazy things," he said. "They told me that if I stopped going to church I'd be damned for sure."

"Like, what would happen?" I asked. "Be more specific."

"Well ...." he hesitated for a moment. "Well, things like, I would fall among loose women, and start drinking and doing drugs ...."

"Well," I asked, "were they right?"

He paused for a minute and a sheepish grin appeared on his face. "Yeah!"

It was funny at the time, but now, thirty years later, I wonder about that guy. Is he still smoking dope, or drinking too much? Is he married? Happily? Does he worry about his kids doing the same things he did when he was in college?

I say this to remind you, yet again, that the fears that motivate the Fundamentalists are well founded. They are fears we can relate to ourselves. We do live in a dangerous, out-of-control world, with too much trash on TV and too many good people falling victim to narcissism, selfishness, and greed. If science is used as a justification to throw out all the old rules, if the "scientific" goals of life are to lead "healthy and self-actualized lives" instead of being good, then they have a right to be suspicious of science.

We know, from our intimate ties to science, that it doesn't have to be that way, but they don't have that experience. There's no way they could know it, if we don't tell them.

A while back I was invited to give a colloquium about the moons of Jupiter at a school where a friend of mine teaches, the College of Charleston in South Carolina. After the talk, one of her students came up to me, all enthused, and he said he wanted to become a geologist. I told him I thought it was a great idea; I love geology.

"But can you help me?" he asked. I thought he wanted a letter of recommendation. What he really wanted was an answer to a question: "What do I tell my Mom?"

In his family, in his world, going into geology meant turning his back on his religion and his upbringing, and they were afraid, turning against everything his family stood for. How could he answer them?

It was a serious question, and we wound up talking about it at some length. There was no simple sound-bite answer. Indeed, the only answer I could come up with was a hard one. If you're going to be a geologist, I said, then you're also going to have to be a very devout, gentle, and good human being. A holy life will be the only response they'll believe, and being good isn't easy.

That sort of attitude, that kind of Fundamentalism, can be very frustrating to deal with. How many times have you wished that you could get just one Fundamentalist alone, to sit down and talk to, and make them listen, make them understand ....

Well, what would you tell a Fundamentalist if you could get them alone, one on one, and you knew they would listen? Maybe you'd want to say things like .... Don't be afraid of new ideas. Don't be afraid to embrace the truth, even if you think there are strong pressures from your family and friends not to. Don't close your mind, don't think you have all the answers, don't depend just on what people tell you, think for your-

self, open your eyes, see the world the way we do ...

Come up with your own list. Then go into the bathroom, take a look at the mirror, and start talking. The things you most want to tell someone else are often the things you most need to hear, yourself.

It's not just the religious right who are Fundamentalists. There are Science Fundamentalists out there, too. Maybe you think those people who express their Christianity by driving around with a fish on the back of their car are guilty of an attitude of arrogant smug self-righteousness; but isn't that exactly the same attitude expressed if the fish has feet and says "Darwin"? Do you think either Jesus or Darwin would approve of having their names taken in vain that way?

It's not just the religious right who are Fundamentalists. There are Science Fundamentalists out there, too. Maybe you think those people who express their Christianity by driving around with a fish on the back of their car are guilty of an attitude of arrogant smug self-righteousness; but isn't that exactly the same attitude expressed if the fish has feet and says "Darwin"?

Too many "public scientists" — the ones who work to get their pictures on TV — proclaim their atheism as if they're afraid that otherwise no one will take them seriously as scientists. If, as I believe, a faith that's afraid of the truth has no faith, then what can you say about a science that's afraid of religion?

I got an interesting clue about how to reach across these barriers a few years ago, back in South Carolina again. If I talk about South Carolina High School Science Standards, you might think the worst; but in fact the science curriculum in the public schools of South Carolina is one of the best in the country. The curriculum was developed by educators in the state and includes issues such as Big Bang cosmology and evolution. When it was developed, the last hurdle was for it to be approved by the state Board of Education.

At that time, the chair of the State Board came from Greenville, the town where Bob Jones University is located — a school that had gotten a lot of bad press up north about its conservative attitudes towards science and religion. Some of the high school educators feared the worst. So they asked a number of us who were both scientists-and-something to come and sit in on the meeting. It was like a bad joke; we had a Protestant, a Catholic, and a Jew, a Black, a White, a Hispanic, and a male and female, all the different bases covered. I showed up in my collar and MIT ring.

None of us said a word at the meeting. None of us had to. The curriculum was roundly praised, and passed without dissent.

Afterwards, the chair from Greenville came up to chat briefly with me. "It's so nice to meet you," she said. "What you are doing at the Vatican Observatory is wonderful work."

The lesson — besides me learning to let go of my northern prejudices — was this: The Fundamentalists are opposed to our science if they see it as a threat to religion. If instead they see science embraced by religion, the fear falls away.

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Which leads to a most embarrassing and impertinent question on my part: Where were you last Sunday morning?

In our society, religion is a very private affair. We tend to shy at proclaiming it from the rooftops, and rightly so. Part of being in a multicultural society is that we expect to be given the space to follow our consciences, and to grant that same space to our neighbors. So when it comes to religion, we normally adopt a "don't ask, don't tell" policy.

However, if we really want to get the point across, forcefully, that science is not a religion, nor a threat to religion, you should be prepared to say what you do think about religion. You should be prepared to talk about your religion.

If you go to a church, you should be sure to mention that fact even if just in passing. To ease the fear and earn the respect of a science-fearing churchgoer, you don't have to go to their church. It's enough for them to see that you go to any church. If nothing else, by doing so you acknowledge that you don't have all the answers; that you're willing to spend an hour a week in the presence of others, acknowledging publicly that we're all pilgrims on the road and none of us can pretend that we already know the way.

If you don't go to a church, ask yourself: why not? Do you think you don't need someone else to ask you unsettling questions at least once a week? There are churches out there even for those who "believe in one God at most," as my Unitarian college roommate used to joke. It's the humility, not the creed, that's important in this context.

I am reminded of the passage in the Book of Job (chapter 38: verses 1, 4-7, 12-13, 16-21) where, after Job is complaining about how God has failed to order the universe to his satisfaction, the Lord answers Job out of the whirlwind:

"Where were you when I laid the foundation of the earth? Tell me, if you have understanding! Who determined its measurements — surely you know! — or stretched the line upon it? On what were its bases sunk, or who laid its cornerstone, when the morning stars sang together, and all the sons of God shouted for joy?

"Have you commanded the morning since your days began, and caused the dawn to know its place? Have you entered into the springs of the sea, or walked in the recesses of the deep? Have the gates of death been revealed to you, or have you seen the gates of deep darkness? Have you comprehended the expanse of the earth? Declare if you know all this!

"Where is the way to the dwelling of light, and where is the place of darkness, that you may take it to its territory and that you may discern the paths to its home? You know, for you were born then, and the number of your days is great."

You can read that passage as a sarcastic put-down of Job's presumption; and certainly it is a call to humility: don't pretend you know it all. However, if you look more closely, it is also an invitation to come learn, because it is only the humility of saying "I don't know" that allows you to follow up by saying, "let's find out."

That's science, and it is rooted in faith. That's where you find God: under the dome, in the dwelling of light. C

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See also David Chandler's "Who Are the Creationists" in Vol. 18, #2, June 1989; John Appledoorn's "The Myth of Galileo" in Vol. 19, #4, December 1990; and Shores' "Religion and the Planetarium", Vol. 22, #3, September 1993. All are posted at the Planetarian web site at www.GriffithObs.org/IPSPlanetarian.html. - JM