

The Galileo Incident: What Today's Christian Can Learn

Lynden Rogers

Dean of the Faculty of Science and Mathematics
Avondale College, Cooranbong, NSW

ABSTRACT

We know that those who fail to learn from the mistakes of history are often condemned to repeat them. Nowhere is this more applicable than in the case of the 450 year old heliostatic challenge posed by the Polish monk, Copernicus. This new paradigm challenged not only the theological structures of the day but a great deal of scholastic wisdom as well, giving rise to a thorough revolution of thought, and introducing the modern scientific age. Difficult conceptual adjustments were required on most quarters. Some of these required two centuries to complete and were achieved only with the greatest of difficulty. This article reviews key elements of Galileo's historic involvement in this controversy and notes four important lessons emerging from his experience. These apply variously to: those seeking to understand the modern scientific process; thought innovators, whether scientific or otherwise; and to those individuals and faith communities seeking an adequate response to new ideas which appear to challenge Christian understanding.

Introduction

Galileo's 17thC brush with ecclesiastical authority has become the "cause célèbre par excellence"¹ for supposing that Christianity and science are irreconcilably opposed. Certainly it has come to symbolise all that is opposite and confrontational between the two. As the most consequential incident among many during Christianity's 200-year adjustment to the new heliostatic cosmology of the Copernican Revolution, it not only continues to haunt the Catholic Church, but fires warning shots across the bow of those currently embroiled in conflicts over Scripture and science. Although this fascinating period can be examined from many different perspectives, the purpose of this

article is to note any lessons applicable to us as we face contemporary science/faith dilemmas. I suggest that there are at least four such, and that any reader of this article is likely to profit from one or more!

The Ptolemaic Era

Christians of the early 1500s thought they understood their universe thoroughly. Indeed, there had been little change for centuries. God had declared the truth about everything worth knowing in the Holy Scriptures, and the church fathers had provided any further clarification required. Three important elements of this worldview may be identified. These are listed below, with some supporting scriptures (KJV).

- (i) The earth was immovable and was not only situated near the centre of the cosmos but was the absolute reference point for it, as demonstrated by such passages as: Ps 93:1, "The earth also is stablished that it cannot be moved"; and Ps 104:5, "...who laid the foundations of the earth that it should not be removed for ever".
- (ii) The sun moved round the earth, as taught by: Josh 10:13, "So the sun stood still in the midst of heaven and hasteth not to go down about a whole day"; 2 Kings 20:11, "And Isaiah the prophet cried unto the Lord: and He brought the shadow ten degrees backward, by which it had gone down in the dial of Ahaz"; Ps 19:4-6, "In them hath he set a tabernacle for the sun, Which is as a bridegroom coming out of his chamber, ... His going forth is from the end of the heaven and his circuit unto the ends of it..."; and Eccl 1:5, "The sun also ariseth, and the sun goeth down and hasteth to his place from whence he arose".
- (iii) This earth had come under the domain of sin whereas the celestial bodies (the sun, moon and stars) were unfallen and perfect, as suggested by Gen 3:17, "...cursed is the ground for thy sake...".

It was a comfortable, anthropocentric

picture, firmly positioned within Ptolemy's 150 AD earth-centred cosmology, the general features of which are represented in the woodcut shown in Figure 1a. At the more technical level of this schema the planets were carried on lesser circles, or *epicycles*, the centres of which traveled on larger circles, or *deferents*. The latter were eccentric, in that their centres did not coincide with the stationary earth. Thus, although Ptolemaic cosmology has often been described as "geocentric", it was only such in the sense that the earth was at the centre of the universe. The planetary orbits were certainly not concentric about the earth. Accordingly, this cosmology is more precisely described as "geostatic".²

Further, in order to make the epicycles move faster when closest to the earth, thus matching observation, Ptolemy introduced the *equant*, a point on the opposite side of the deferent centre from the earth, about which the angular motion of the epicycle around the deferent was constant. Clearly, the planets did not move in an even, circular motion! Although clumsy and somewhat contrived, this cosmology successfully described all planetary movements, including their apparent periodic reverses of direction or so-called retrograde motion, and was generally consistent with Aristotelian physics. But how soon all this was to change...

The Copernican Revolution

Although it was not immediately obvious to all, the gauntlet was effectively thrown down to this traditional understanding by the publishing in 1543 of a major work entitled *De Revolutionibus Orbium Coelestium* (On the Revolutions of the Heavens) by the Polish monk Nicolaus Copernicus (1473-1543). His major innovation was to interchange the sun and earth, thus placing the earth as well as all the other planets in orbit about the great luminary. This adjustment explained the apparent retrograde motion of the planets in terms of their regular motion in one direction and eliminated a number of epicycles at a stroke, which was very elegant. Furthermore, when the orbits of the other planets were scaled to that of the earth a striking consequence emerged. All the planets were automatically arranged in order of the period of their solar orbits, with Mercury closest to the sun and Saturn at the outer extremity. Although at the cost of reintroducing small epicycles, Copernicus also managed to eliminate Ptolemy's equant, a feature which he and many others particularly disliked because of its adverse effect on uniform circular motion. However, these small epicycles meant that, as for the Ptolemaic model, the planetary orbits were not exactly concentric about the central body. For this reason, the system is not truly "heliocentric" and is more accurately described by

the term "heliostatic".³ Although these latter constructions resulted in a total of 34 circles, actually slightly more than in the Ptolemaic model,⁴ the overall effect was much more mathematically systematic and aesthetically pleasing and, according to Gingerich, achieved "a compelling unification of the disparate elements of the heavenly spheres".⁵ To Copernicus, firmly located as he was in the neo-Platonist tradition which almost worshiped mathematics, the consequences noted above spoke of the authenticity of his cosmological arrangement.

However, mathematical harmony and aesthetics appeared to most then (and many now) as strange and unpersuasive grounds on which to argue physical issues, particularly when only a very few mathematical practitioners could appreciate this new harmony and symmetry. Further, as urged by the traditionalists, Copernicus' arguments did not explain any astronomical phenomena not already understood according to the reigning Ptolemaic paradigm. True, the new Copernican system *was* elegant, as noted above, but such evidences had little appeal to Aristotelian scholastics and Church authorities who, even when they understood the arguments, were "unwilling to substitute minor celestial harmonies for major terrestrial discord".⁶ As we shall shortly discuss, it was not long until the major discord arrived! (Incidentally, in this

respect Copernicus was a master strategist. Realising the potential for opposition, he wrote his book in such technical language that it was “unreadable to all but the erudite astronomers of his day”.⁷ In addition, he dedicated *De Revolutionibus* to the Pope, Paul III, probably as a further safeguard. He also died soon after the publication of his volume, thus making his immunity from persecution complete!)

In 1588, during the midst of this minor turmoil, the Danish astronomer, Tycho Brahe, posited a compromise which embodied some Copernican elements, while still satisfying those who could not accommodate notions of a moving earth. He conceded

that the other planets did revolve about the sun but suggested that this sun-planet system, and also the moon, revolved around the large and stationary earth. This rather contrived “Tychonic” system found little favour among astronomers and would not long persist, although it did provide a stepping stone for those initially unable to make the long jump to Copernicanism.⁸ Figure 1 shows a medieval woodcut of the Ptolemaic system, together with representations of the Tychonic and Copernican systems.

Galileo

Galileo Galilei, the son of a musician, was born in 1564, the year of Shake-

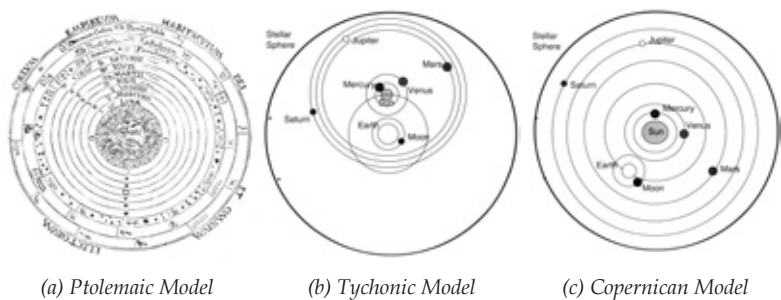


Figure 1

speare's birth and Michelangelo's death, and became the most renowned physicist since Archimedes. Galileo was professor of mathematics at Padua when he first heard of a new invention, the optical tube (not yet called a telescope), which was being demonstrated in Venice. Fortunately Venice had a flourishing glass industry, and soon he was making his own optical tubes or "perspicillums" as he called them. His most famous instrument acquired the name "Old Discoverer". (It should be remembered that his best telescope was inferior to a good modern set of binoculars!) By November 1609, he was pointing his new instruments at the moon. The shadows and craters he observed were clearly in conflict with prevailing theories on the appearance of heavenly bodies, which were supposed to be perfect, changeless spheres. He also observed irregularities on the sun's surface, now called "sunspots". In January 1610 he viewed Jupiter, noting four small companions to the great planet that seemed to change their relative positions. He correctly deduced that these were satellites of Jupiter. Galileo quickly wrote an account of these discoveries, entitled *Siderius Nuncius* (Starry Messenger), and rushed it to the printer. Galileo called the four new moons "Medicean Stars", thereby hoping to curry favour with Grand Duke Cosimo II de' Medici, and consequently to obtain a position at his court in Florence. He was, after

all, tired of teaching students and ambitious for higher things!⁹

It worked, and Galileo moved to Florence, insisting on the title of court "Philosopher and Mathematician".¹⁰ This was important to him, as mathematics and astronomy were not regarded as high level (or high paying) academic pursuits. Indeed mathematics was not seen as having much at all to contribute to the discussion on the physical function of the universe. In order to be taken seriously, Galileo needed to be accepted as a philosopher.

However, his new celebrity status proved difficult to sustain. After all, there were not many heavenly bodies that could be studied through his primitive telescope. Although disappointed that the other planets didn't seem to have any new moons awaiting discovery, Galileo soon realised that Venus might aid his ailing cause by providing evidence for or against the new Copernican cosmology, in which, up to this time, he had only taken a passing interest. According to the Ptolemaic model Venus could never be on the other side of the sun, and hence could never shine with a full phase (ie, like the full moon). However, according to the Copernican view and, frustratingly, also the Tychonic model, this was quite possible and should be observable.¹¹ If he could only demonstrate the falsehood of the prevailing cosmology that would really justify his new

job! It was a few months, however, before any conspicuous changes of phase occurred and not until New Year's Day 1611 did his observations finally confirm the full phase to his satisfaction. Immediately he fired off the now famous message intended for Kepler, "Cynthiae figuras aemulatur mater amorum" ("The Mother of Loves imitates the shapes of Cynthia"), announcing his discovery.¹² Galileo, now a confirmed and card-carrying Copernican, lost no time in publicising the implications of this new discovery, although choosing to disregard any support his observations may have lent to Tycho's despised model.

One result of this enthusiastic campaign was a request by Cosimo's mother, the devout and highly influential Dowager Grand Duchess, to Benedetto Castelli, one of Galileo's former pupils and now his closest colleague, asking him to explain why the Copernican system was not in conflict with the Scripture. Galileo's responses, a letter to Castelli, followed by the longer, open "Letter to the Grand Duchess Christina", were immediately circulated in Rome. It is in the latter work that we find his famous epigram about the Bible teaching "how to go to Heaven and not how the Heavens go". (In fact Galileo borrowed the saying from Cardinal Caesar Baronius, the Vatican librarian).¹³ The second letter elicited a significant response from Cardinal Roberto Bellarmino, the

leading Catholic theologian of the day, who wrote to Father Foscarini, another Copernican:

First, I say that it appears to me that Your Reverence and Signor Galileo did prudently to content yourselves with speaking hypothetically and not positively, as I have always believed Copernicus did. For to say that assuming the Earth moves and the Sun stands still saves all the appearances better than eccentrics and epicycles is to speak well. This has no danger in it, and it suffices for mathematicians.

But to wish to affirm that the sun is really fixed...is a very dangerous thing, not only by irritating all the theologians and scholastic philosophers, but also by injuring our holy faith and making the sacred Scripture false.¹⁴

Clearly Bellarmino recognized a conflict between Copernicanism and Scripture and by 1616 it was obvious that the new cosmology was becoming a source of annoyance to the church. Two actions were planned: to put *De Revolutionibus* on the "Index", the list of books forbidden to Catholics, and to rein in Galileo. However, the first measure was fraught with difficulty. Along with others, the liberal and astute Cardinals Barberini and Caetani pointed out that while there were undeniable difficulties associated with the moving earth as proposed

by Copernicus, his tables of solar events were demonstrably superior to any that existed previously. This meant that they were of great use in the ongoing process of calendric reform, so essential to the complex Catholic ecclesiastical program and thus close to its heart. Accordingly, they urged the pope not to forbid the book but to “expurgate and emend” it instead.¹⁵

In order to restrain him, Galileo was ordered before Cardinal Bellarmino, who was instructed by the pope to caution him about forcefully promoting Copernicanism. To ensure the pope’s wishes were observed, the interview was conducted in the presence of two Dominican friars associated with the Holy Inquisition. As it turned out, however, Galileo was uncharacteristically cooperative and the meeting went well. Soon afterwards, Galileo, disturbed by rumors that he had been subjected to penance and expressly forbidden to speak out about Copernicanism, requested a clarifying letter. In response, Bellarmino’s letter of May 26, 1616 read in part:

We, Roberto Cardinal Bellarmino, having heard that it is calumniously reported that Signor Galileo Galilei has in our hands abjured and has also been punished...declare that the said Signor Galileo has not abjured...any opinion or doctrine held by him; neither has any salutary

penance been imposed on him; but that only the declaration made by the Holy Father and published by the Sacred Congregation of the Index has been notified to him, wherein it is set forth that the doctrine attributed to Copernicus...is contrary to Holy Scriptures and therefore cannot be defended or held.¹⁶

Galileo behaved himself for the next seven years, after which came news that cheered all liberal Catholics. Maffeo Barberini, one of the two cardinals who had earlier intervened to prevent the proscription of *De Revolutionibus*, had been elected pope. Before a year had passed, Galileo was in Rome for a series of papal audiences with the new pontiff, who had taken the name Urban VIII.

The pope assured Galileo that he had had some of the latter’s recent publications read to him to his great personal enjoyment and profit. As a result of these talks, Galileo received the gracious papal blessing to write cautiously on Copernicanism, although it was suggested that any publications should give a balanced presentation and should not rely too heavily on Galileo’s new argument based on tides. From the pope’s viewpoint, this argument did not really strengthen the Copernican position against the Tychonic, since Galileo had failed to establish a definite causal relationship between the earth’s movement and tidal flow. (In-

cidentally, the pope was absolutely right! Galileo's argument was later recognised as fallacious.)

Fired up by these new freedoms, Galileo proceeded to write his *Dialogue* between three speakers: Simplicio, a traditionalist named after a 16th century commentator on Aristotle but whose name has an obvious double meaning, Salviati, who most often speaks for Galileo himself, and Sagredo, an open minded man of the world who asks intelligent and leading questions and who is generally persuaded by Salviati's sagacious reasoning. Although a license to print this book was eventually issued by Riccardi, the church official responsible for approving new publications, it could hardly have been considered neutral. To make matters worse, unbeknown to Riccardi, Galileo had placed the papal warning concerning the argument based on tides, in the mouth of Simplicio, and at the end of the book!¹⁷ Understandably, the pope was furious, and in February 1633, at the age of 70, Galileo was ordered to Rome.

He was tried before a tribunal of 10 cardinals and accused of disobedience. There was an attempt to get Galileo to admit that Bellarmino (now deceased) had served him an injunction 17 years earlier. Eventually Galileo produced Bellarmino's 1616 letter, of which the pope and cardinals had been unaware, tem-

porarily defeating them. However, the pope could not afford the embarrassment of bringing Galileo to Rome for naught. Galileo was shocked when on June 16, 1633 he learned that he had been found guilty notwithstanding and the following sentence had been entered in the Book of Decrees:

Galileo Galilei...is to be interrogated...even threatened with torture, and if he sustains it, proceeding to an abjuration of the vehement [suspicion of heresy] before the full Congregation of the Holy Office, sentenced to imprisonment.....¹⁸

He was forbidden to write further on the mobility of the earth and the *Dialogue* was banned! On the next page is recorded Galileo's submission:

I do not hold and have not held this opinion of Copernicus since the command was intimated to me that I must abandon it....¹⁹

He was then told again to speak the truth under threat of torture. The confession was properly signed in Galileo's hand. He was sent back to his home in Florence where he remained, still a devout Catholic, but under house arrest for nine years until his death in 1642, the year in which Isaac Newton was born.

Theological Problems Posed By Copernicanism

Before we look for lessons it is useful to review the theological challenges

posed by the heliostatic theory to the medieval Christian worldview earlier outlined. Clearly for Catholic scholars the major concern was the obvious disagreement of a stationary sun and moving earth with Church authority and the plain words of Scripture quoted earlier in support of the first two elements of the pre-Copernican worldview. However, as Kuhn pointed out,²⁰ the new cosmology also violated the third element, namely the idea that the earth alone was cursed while the rest of the universe remained pristine. If the earth was just a planet, participating in the (perfect) circular motion of the un-fallen heavenly bodies, how could it simultaneously be a sink of iniquity?

Later, when Galileo's telescope discovered the irregular surface of the moon, and spots on the sun, the converse also became a problem; that is, how could a perfect body like the sun have imperfections such as sun-spots? But it was even worse than that. How could these spots come and go, which these seemed to do? How could perfect bodies change? Finally, and perhaps worst of all, the motion of the spots across the sun's disk indicated that the sun rotated on its axis, providing a visible paradigm for the axial rotation of the earth. It was dreadfully confusing! Clearly, these concerns also suggested more fundamental questions concerning the nature of inspiration and the authority of Scripture. How could

Copernicus and his followers be right when Holy Writ seemed so specifically against their innovation?

Protestant leaders were generally less threatened by these arguments. Although some authors²¹ have cited statements by Luther and Calvin as evidence of their theological opposition to Copernicanism, later scholarship has revealed the need for caution. Luther's only known comment was made in the context of a meal-time discussion in 1539, four years before *De Revolutionibus* was published, and was recorded some years after the event. Although it appears that Luther did cite Joshua 10:13 as evidence against Copernicus, it seems likely that his response owed more to his commonsense reaction than to theological aversion.²² The lack of any further comment on this topic by the great reformer would appear to support this view. Calvin's most cited comment, supposedly pitting Copernicus against the Holy Spirit, was shown in 1960 by E Rosen to be apocryphal!²³ However, this restitution was challenged in 1971 when it was noted that in a sermon on 1 Cor 10 Calvin had denounced "those who say that the sun does not move and that it is the Earth that shifts and turns." Once again though, the absence of any follow-up remarks suggests that Calvin's response was not primarily motivated by theological concerns.²⁴

By the late 16th C, however, a

new Protestant scholasticism had emerged. Possibly within this context, Philip Melanchthon did unequivocally oppose Copernicanism, invoking both the logic of appearance and Scripture:

The eyes are witnesses that the heavens revolve in the space of 24 hours. But certain men, either from the love of novelty, or to make a display of ingenuity, have concluded that the earth moves; and they maintain that neither the eighth sphere nor the sun revolves.... Now, it is a want of honesty and decency to assert such notions publicly, and the example is pernicious. It is part of a good mind to accept the truth as revealed by God and to acquiesce in it.²⁵

Melanchthon then quoted a number of anti-Copernican biblical passages. On other occasions he urged that severe measures be taken to restrain the impiety of the Copernicans.²⁶

Although all Christians eventually accepted the sun-centred view, the theological questions kept coming, particularly as telescopes improved. If the universe is undergoing continual change and process, how can it be said that the heavens are part of a completed creation? What may be inferred about God's sense of aesthetics if the heavenly regions consist of exploding gas balls and seemingly random and chaotic processes? Further discoveries transformed not

only the earth but also the sun and the entire solar system to insignificant specks lost in the infinitude of God's creation. The safe, anthropocentric, "geocentric" universe of man was lost. As stated by Thomas Kuhn, "...the compact and ordered cosmos of the scholastics had become a vast chaos; ...".²⁷

Now for the Lessons...

(i) **For Those Unaware of the Rules for Evaluating Competing Scientific Theories**

It is important to note an important scientific consequence of these events. Up until Galileo's era, scholastic argument was largely couched in terms of propositional proof in the classic deductive sense. In his *Dialogue* Galileo did his best to utilise this classical argumentation, pointing out that the phases of Venus deductively eliminated the Ptolemaic model. However, as we have noted, the observations of Venus did not similarly discount the Tychonic schema. This was very much to Galileo's frustration and it was largely to falsify this latter model that Galileo advanced his tidal argument for the earth's movement, only to have it challenged by the pope.

Perhaps sensing that his thesis was at risk, Galileo also advanced a new style of argument, one which emphasised the *coherence*, *synthetic power*, *mathematical elegance*, *consistency* and *cohesion* of the Copernican model. He pointed out that while it was possible

to explain all the individual observations: the phases of Venus, the orbital periods and retrograde motion of the planets and the tides by alternative means, the new model explained them all by a single unifying idea, with no special pleading, and with great mathematical elegance. Gingerich, noting this shift of argument away from deductive proof, points out that the end product is then less susceptible to such disproof.²⁸ Thus it was that even when his tidal argument was later discounted, the essential argumental edifice which Galileo had constructed remained securely intact. This is illustrated in Figure 2, where coherence and pattern clearly enable the identification of Galileo in the photo, even though parts of the image are obscured.

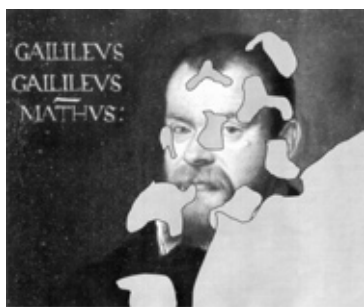


Figure 2

This technique would soon yield even greater support to the heliostatic view at the powerful hand of Isaac Newton, who devised a comprehensive theory explaining the movement of both terrestrial and astronomical bodies. His starting points were

Kepler's significant refinements to the Copernican theory and his own "law" of gravity. Although neither element could be classically "proved", the astonishing success of Newtonian mechanics (for example, in explaining Kepler's three laws) demonstrated the likely veracity of both assumptions. It was enormously persuasive, and by Newton's death the intellectual debate was over. The planets orbited the sun!

It was 200 years after Galileo before the appearance of the deductive arguments for which he had sought in vain. In 1838 stellar parallax, the measurement of different angles subtended by certain near stars when observed from opposite sides of our earth's 149,000,000 km radius orbit about the sun, demonstrated the earth's annual traverse. Soon after, in 1851, the precession of the arc of Foucault's famous pendulum argued for the daily rotation of our planet. However, no particular excitement greeted these discoveries. The fact was that no one was surprised.²⁹ The collective scientific mind had been led to this understanding years earlier according to the criteria initially urged by Galileo, now known as the *hypothetico-deductive* process and one of the essential yardsticks of science. (Incidentally it must be noted for the record that controversy over this aspect of the scientific method did persist in certain quarters. For example, the mixed response by scientists to Darwin's *Origin of Species*

was due in part to different views over the relative role of inductive and deductive reasoning.)³⁰

When faced with two competing theories scientists will choose the one that offers the most comprehensive, coherent, cohesive and consistent explanation with the least special pleading. This is not well understood by many creation scientists, who seek to buttress their position by presenting apparent exceptions to the accepted scientific paradigms and also by stressing the assumptions made by scientists, while ignoring the enormously persuasive mass of concordant data on which the paradigm is based. Of course there are such exceptions and assumptions, but this strategy is flawed. The only means of successfully challenging a scientific view is to demonstrate an alternative model, one that gives an even clearer explanation of the factual base. We must catch up to Galileo!

It is possible that, in fact, Galileo took his cue in this matter from the author of *De Revolutionibus* himself. In its opening pages Copernicus stressed the coherence of the new view he was presenting, in one place writing:

Therefore in this ordering we find that the world has a wonderful commensurability and that there is a sure bond of harmony for the movement and magnitude of the orbital circles such as cannot be found in any other way.³¹

(ii) For Intellectual Innovators

It must be said that the Galileo story may have had a happier ending with a different protagonist. Galileo's egotistical and feisty manner earned him the enmity of those who might have been his friends when he most needed them. As Piero Guicciardini, the nervous Tuscan ambassador to Rome complained to the Grand Duke, "For he is vehement and stubborn and very worked up in this matter and it is impossible, when he is around, to escape from his hands".³² His caustic pen further alienated those whose mind did not move as quickly as his, but who may well have been persuaded by a better-staged and more empathetic campaign. Instead, his style emphasised difference rather than commonality, and he tended towards impatience. Finally, Galileo betrayed the pope's trust, in the process ridiculing an argument that would soon be verified. This overreaching of his case has loomed over Galileo, a circumstance that should inspire caution in his modern counterparts.

Had he presented his case a little more tentatively, and been more politically astute, he might have retained the papal blessing and continued writing on Copernicanism. In fact Galileo had an unusual and conspicuous advantage. Urban VIII was, as we have seen, a progressive scholar, and able to understand the issues better than most. Thus

a happier ending might have been anticipated in this circumstance than for most others. Galileo blew this opportunity for an effective foothold by failing to consider the politics and stresses of administration. As a consequence, his many gifts did not bear fruit as quickly as they might have done.

(iii) For Those Who Think That Nothing Should Influence Theology

A significant cause of Galileo's ultimate predicament was his insistence that mathematics was the language of the universe. Aristotelian wisdom had explained the physical function of the universe for over a millennium without significant recourse to mathematics, although during the two centuries preceding Galileo there had been considerable mathematical development of Aristotelian thought.³³ As noted earlier, however, mathematics had a very subordinate status compared to philosophy. Indeed, many of his philosophically informed protagonists not only failed to appreciate Galileo's arguments but also pitied him for supposing that his observations and mathematical structures could be relevant to a question on reality! Interestingly, this view has now been so far reversed that the noted physicist PAM Dirac frequently told astonished students that if the choice was between a theory that seemed to fit the facts, but was mathematically clumsy, and an-

other which seemed unsupported by data yet was mathematically elegant, they should choose the second every time!³⁴ Physics has repeatedly demonstrated the truth of this dictum. It is because of this basic epistemological difference between Galileo and his opponents that Gingerich points out that the latter probably would not have been convinced, even had he been able to muster arguments such as stellar parallax.³⁵

This scenario demonstrates the danger of assuming a priori that any thought tradition is irrelevant to another. With little extension it might caution against assuming that science cannot inform theological understandings. Further to this question, in 1992 the Catholic Church officially admitted that Galileo's theological insights surpassed those of his ecclesiastical opponents.³⁶ There can be no question that over the last 400 years science, like archaeology and history, has informed many theological perspectives, although its proper place in this respect is an ongoing study.

(iv) For Churches Confronted by Intellectual Innovators and New Thought

In attempting to define scientific truth, Galileo's ecclesiastical judges were seeking to prevent the development of an autonomous science. They felt that "The motions of the heavenly bodies, ... , having been touched upon in the Psalms, the

Book of Joshua, and elsewhere in the Bible, were matters best left to the Holy Fathers of the Church".³⁷ Ironically, however, their ruling initiated precisely the autonomy they sought to prevent. As Dorn points out, the modern process of secularisation in fact began with Galileo's sentence.³⁸ In his *Dialogio* Galileo spoke repeatedly of God, while in his *Discorsi*, written after the trial, he does not mention God once.³⁹ Could Galileo have possibly sensed, and quickly responded to, a watershed erosion of Christian credibility? Von Weizacker and Kuhn, among others, have claimed that no single action has done more harm to Christianity than the sentence against Galileo.⁴⁰ While the Church certainly affirmed its authority successfully in the short term, it ultimately lost that authority decisively. Time demonstrated that even the Catholic Church could not decree scientific truth. As a result of Galileo's persecution, creative scientific thought moved from Italy and concentrated northward in the Protestant countries.⁴¹

As we have noted, there is no doubt that Galileo was provocative, ambitious, politically naïve and at times even wrong with his science. However, these factors have not much mitigated the judgment of history on Urban VIII and his colleagues, or prevented the ongoing consequences of their mistake. Indeed, as noted above, the Catholic Church is still smarting from this humiliation, even

after its admission that Galileo's science and theology had been essentially correct. All now acknowledge that he had been genuinely trying to "protect the honour of the Catholic faith", by preventing the Church from making a costly mistake.⁴² In this his foresight was impeccable. Modern Galileos may be similarly rambunctious, and their causes might seem equally troublesome to heavily burdened church leaders. However, a moment's reflection on the invidious position of Catholicism over 350 years should surely discourage precipitate judgment. It is also worth reflecting on the difficulty of reversing a poor decision once ecclesiastical machinery has rumbled into motion. It is much better not to make it in the first place!

Science owes much to the Christian world-view,⁴³ and at least in its initial phases, was largely developed by devout Christian practitioners.⁴⁴ As Brooke points out, Robert Boyle and John Ray, among others, "envisaged scientific inquiry itself as a form of worship".⁴⁵ Although there were many other secularising factors,⁴⁶ it is sadly ironic that inappropriate church responses to the revelations of science at times accelerated the latter's repudiation of that faith heritage. If we can only maintain safe confines, within which "hypothetical" matters of delicacy can be considered and weighed by experts over time, and if we can see beyond the

foibles of those carrying unwelcome messages, might we not prevent modern Galileo incidents?

The Copernican revolution demonstrated that there is much about the universe that is not explicitly spelled out in Scripture. This in itself represented a radical change in Christian thought. The fact that some of the controversial arguments from this era sound amusing today is an indication of just how much scientific progress has changed our religious perceptions. In the words of Thomas Kuhn:

During the century and a half following Galileo's death in 1642, a belief in the earth-centred universe was gradually transformed from an essential sign of sanity to an index, first, of inflexible conservatism, then of excessive parochialism, and finally of complete fanaticism.⁴⁷

Both Catholics and Protestants who opposed the new thought believed sincerely that they were demolishing bad science with Scripture, while in reality they were opposing good science with their own inadequate interpretations of Scripture. Interestingly, Christianity has survived these changes, despite warnings to the contrary. And who is to say that our present understanding of the universe is not a far nobler truth than that for which so many vainly contended?

Questions

- Can you identify any issues arising from the Copernican Revolution which some contemporary Christians may not yet have resolved?
- Can you think of any other examples of a "Tychonic" model, namely one which is not really very good, but functions for a time as a stepping stone for those unable to make the long jump to a new paradigm?
- The Catholic Church was in a sense "hoist on its own petard" in that whilst it wanted to ban Copernicus' *De Revolutionibus*, it recognised the significant value of the book to one of its own primary agendas, namely calendric reform. Can you think of any modern equivalents to this situation, for example, a modern faith community who highly values education but might at the same time be distrustful of its effects? Perhaps you can identify a group who endorses science in one sphere whilst at times condemning it in another?
- Unlike the Catholic theologians, most of the reformers did not see the Scriptures as a textbook in science, and to the best of our knowledge had no essential theological problem with Copernican thought. As we have seen, however, Melancthon was certainly slow to accept the

new ideas, even imputing base motives to the scientists who espoused them. Even if such resistance was more on the basis of his perception of common sense than an outgrowth of his theology there may still be a problem. How do you reconcile such mistakes of fact and attitude with the idea of God having greatly used such a man to instruct the Church? (Remember also that Luther, while we have no record of his opposing Copernicanism in any sustained fashion, was manifestly and virulently anti-Semitic!)

References

1. Finocchiaro, M A (1989). *The Galileo Affair – A Documentary History*. University of California Press, Berkeley, p3.
2. Cohen, I B (1987). *The Birth of a New Physics*. Penguin, UK, pp29-35. Originally Cohen, I B (1961). Heinemann, UK.
3. *Ibid*, p44. Also Hawking, S (Ed) (2002). *On the Shoulders of Giants*. Running Press, Philadelphia, p5.
4. Gingerich, O (2004). *The Book Nobody Read*. Heinemann, London, p58.
5. *Ibid*, p53.
6. Kuhn, T H (1957). *The Copernican Revolution*. Harvard University Press, Massachusetts, p181.
7. *Ibid*, p185.
8. *Ibid*, pp200-206.
9. Gingerich, O (1992). *The Great Copernicus Chase*. Sky & Cambridge University Press, Cambridge Mass, p98. Also Sobel, D (2000). *Galileo's Daughter: A Historical Memoir of Science, Faith, and Love*. Penguin, New York, p36.
10. Gingerich, O (2003). Truth in Science: Proof, Persuasion, and the Galileo Affair. *Perspectives on Science and Christian Faith*, 55(2), p82. Also Sobel, D (2000). Note 9, p36.
11. Sobel, D (2000). Note 9, p74.
12. Gingerich, O (1992). Note 9, pp101, 102, 110.
13. *Ibid*, p111. For position of quotation in full letter see Finocchiaro, M A (1989). Note 1, p96.
14. *Ibid*, p112. For full letter see Finocchiaro, M A (1989). Note 1, pp67-69.
15. *Ibid*, p113. Also Sobel, D (2000). Note 9, pp136-138.
16. *Ibid*, pp114,115. Also Finocchiaro, M A (1989). Note 1, p153.
17. Birkett, K R (1996). Galileo: History v. Polemic. *Kategoria*, 1, pp34, 35.
18. Gingerich, O (1992). Note 9, p119.
19. *Ibid*, p120.

20. Kuhn, T (1957). Note 6, pp193, 221.
21. White, AD (1955). *A History of the Warfare of Science with Theology*. Braziller, New York, pp126,127. (Originally White, A D (1896). *A History of the Warfare of Science with Theology*. Dover, New York.) Quoted by Kuhn, T H (1957). Note 6, pp191,192. Also Cohen, I B (1987). Note 2, p51.
22. Kobe, D H (1998). Copernicus and Martin Luther: an encounter between science and religion. *American J Physics*, 66(3), pp190-196.
23. See Gingerich, O (2004). Note 4, p138.
24. See *Ibid*, p138. Also see White, R (1980). Calvin and Copernicus: The Problem Reconsidered. *Calvin Theological Journal*, 15, pp233-243.; Brooke, J H (1991). *Science and Religion: Some Historical Perspectives*. Cambridge University Press, Cambridge, pp96, 97.
25. Melanchthon, P. From *Elements of Physics* (1549). Quoted in White, A D (1955). Note 21, pp126, 127. (Quoted by many subsequent authors).
26. *Ibid*, p127.
27. Kuhn, T H (1957). Note 6, p235.
28. See Gingerich, O (2003). Note 10, pp85-87.
29. Gingerich, O (1994). Is there a role for Natural Theology Today?, in Rae, M, Regan, H and Stenhouse, J (Eds). *Science and Theology: Questions at the Interface*. T & T Clark, Edinburgh, p43. Also Gingerich, O (2003). Note 10, p85.
30. Hull, D L (1973). *Darwin and His Critics*. Harvard University Press, Cambridge Mass, pp10-66. Also Gauld, C (1992). Wilberforce, Huxley and the Use of History in Teaching About Evolution. *The American Biology Teacher*, 54(7), pp408, 409.
31. Copernicus, N. From *De Revolutionibus* (1543). Quoted in Hawking, S (Ed) (2002). Note 3, p32.
32. Sobel, D (2000). Note 9, p73.
33. Dijksterhuis, E J (1961). *The Mechanisation of the World Picture*. Oxford University Press, London.
34. Quoted by Polkinghorne, J C in "Cosmic Richness", Lecture of June 25, 2003, at 3rd International Philosophy, Science and Theology Festival, Grafton, NSW, Australia.
35. Gingerich, O (2003). Note 10, pp83-87.
36. Reston, J (1994). *Galileo: A Life*. Cassell, London, p283.
37. Sobel, D (2000). Note 9, p7.

38. Dorn, M (2002). www.grisda.org/2003-FSC/email/30304.htm.
39. *Ibid*.
40. von Weizacker, C. Quoted in *Ibid*, Also see Kuhn, T (1957). Note 6, p199.
41. Gingerich, O (1992). Note 9, p105.
42. Sobel, D (2000). Note 9, p74.
43. Jaki, S L (2000). *The Savior of Science*. Eerdmanns, Grand Rapids Michigan.,

Jeeves, M A and Berry, R J (1998). *Science, Life and Christian Belief – A Survey and Assessment*. Apollos, UK, Ch1.,

Kaiser, C (1991). *Creation and the History of Science*. Pickering, London, pp6-11, 15-34, 76-92.,

Lindberg, D C (1992). *The Beginnings of Western Science*. University of Chicago Press, Chicago, pp149-151, 157., and

Polkinghorne, J C (1986). *One World: The Interaction of Science and Theology*. Princeton University Press, Princeton NJ, p1.
44. deBerg, K (2002). Science and Religion: Friends or Foes. *Christian Spirituality and Science*, 3, pp10-13. Also see Brooke, J H (1991). Note 24, pp16-25.
45. Brooke, J H (1991). Note 24, p18.
46. McGrath, A (2002). *The Re-Enchantment of Nature*. Hodder and Stoughton, London.
47. Kuhn, T (1957). Note 6, p227.