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Galileo, the Church, and the Cosmos

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Galileo's struggle with the Roman Catholic church over the arrangement of what we now call the "solar system" was a multifaceted event. It is well known, of course, that it was a clash of ideas—between scientific claims fervently held by a small band of scientific reformers on the one hand and opposing theological doctrines supported by centuries of church tradition on the other. Unfortunately, this version of the story has proved itself vulnerable to simplistic black-and-white elaborations. In the overheated rhetoric of the likes of Andrew Dickson White and many popular writers, this has become a tale of combat to the death between the voices of scientific freedom and the forces of theological intolerance—and, as a welcome bonus, an opportunity to bash the Catholic church.[1] As such, it may make good drama, but it is seriously deficient as history.

Other writers, with the same concentration on cosmological and theological ideas but with greater respect for the historical record, have published nuanced studies that explore the quality of Galileo's cosmological arguments and the nature of the theological currents then at work in the Catholic church. Here we begin to see important aspects of the struggle between Galileo and the leadership of the church. At stake were not only the meaning of certain biblical passages that addressed (or appeared to address) cosmological issues, but also the larger question of who had the right to determine cosmological (and other scientific) truth. Tension over such matters has had a long history within Christendom, and it was an important factor in the Galileo affair.

But if we were to stop here the story would be incomplete, for (as sketched above) it omits the human dimension. We must never forget that, strictly speaking, ideas cannot clash and theoretical claims cannot, of themselves, engage in combat. It is people who fight over theoretical and methodological claims, people who clash over ideological issues. And when people are involved, human interests and local circumstances are inevitably present as well. My purpose in the present essay, therefore, is to bring the story down to Earth and reveal it as a concrete historical event, situated in time and space—influenced, without a doubt, by cosmological and theological beliefs, but also powerfully shaped by local circumstances and the interests of an important group of historical actors.[2]

Galileo Galilei (fig. 2.1) was born on 15 February 1564 in the city of Pisa—some fifty miles from Florence, under whose control it had fallen in 1406. The eldest son of a court musician of considerable talent, Galileo was educated first in Pisa, later in a monastery school in the hills outside Florence. In 1581 he took up medical studies at the University of Pisa, but a year later he abandoned them; subsequently he studied mathematics privately with a tutor and in the long run

Figure 2.1. Galileo Galilei (1624).

undertook an extended program of self-education. He never earned a university degree, but he eventually became a university professor. In 1589 Galileo assumed teaching duties in mathematics at the University of Pisa, thanks to the intervention of Guidobaldo del Monte, a distinguished mathematician and an influential member of the nobility. Three years later Galileo moved to the University of Padua (in the Venetian Republic), where he remained until 1610, when he resigned in order to return to Florence as philosopher and chief mathematician to the grand duke of Tuscany.[3] Galileo first became seriously involved in the heliocentric debate just before this return, in the years 1609–10.

Heliocentrism

What was this heliocentric debate? Western cosmologies, since at least the fourth century B.C., had been geocentric: they had featured a spherical earth in the center of the universe and assigned planetary status to the Sun, which circled the earth with a daily motion.[4] This was the view of the Greek philosopher Aristotle (d. 322 B.C.), the Greek astronomer Ptolemy (fl. A.D. 150), and their many medieval commentators. Heliocentric (Sun-centered) systems were not unheard of, but they survived in late antiquity and the Middle Ages merely as curiosities. However, in 1543 Nicolaus Copernicus, a church official and accomplished astronomer from northern Poland, published a book, *On the Revolutions of the Celestial Orbs,* in which he took the heliocentric system (now fully equipped with mathematical models capable of predicting planetary positions) and defended it as a true description of the universe.

Copernicus's book was a highly technical astronomical text, dominated by detailed geometrical models for all of the planets; and we must make a brief foray into these geometrical details if we are to understand what was at stake in the heliocentric debates. The fundamental idea underlying Copernicus's models was borrowed from Ptolemy—namely, that two or more uniform circular motions can be combined to produce a nonuniform composite. If we set aside various complexities, Ptolemy's basic geocentric model can be represented as follows (fig. 2.2): a given planet P moves uniformly around a small circle called an "epicycle"; meanwhile, the center of this epicycle moves uniformly around a large circle called a "deferent" (or carrying circle), the center of which is at point C. These two uniform circular motions, when combined and viewed from the fixed earth, are meant to replicate the observed behavior of P as viewed against the background of the fixed stars. However, to produce models that actually worked with quantitative precision, Ptolemy found it necessary to complicate the geometry in two ways. First, he was willing to shift the deferent slightly, so

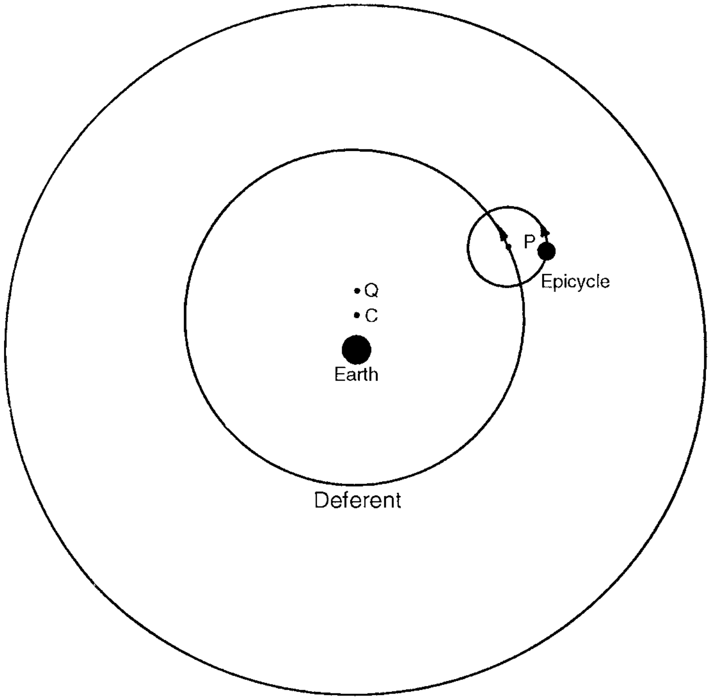

Figure 2.2. Ptolemaic geocentric model for a typical planet. The various elements in this and other geometrical diagrams in this article are not drawn to scale.

that its geometrical center no longer coincided with the geometrical center of the earth (which remained in the center of the universe). Second, he allowed the center of the epicycle to move about the deferent with a motion that swept out equal angles in equal times as viewed *not* from the center of the deferent (as a straightforward understanding of the expression "uniform motion" would seem to require), but from a noncentral point, the "equant point" Q. This device, while retaining uniformity of angular motion about the equant point, actually allowed the center of the epicycle to move with variable speed around the circumference of the deferent.

Copernicus's models (fig. 2.3) differed from those of Ptolemy in a number of minor respects, but two major ones deserve mention. First and most obviously, the central cosmological object in the Copernican system was the Sun; in the Ptolemaic, the earth. Second, Copernicus banished the equant from his heliocentric model in favor of uncompromised uniformity of motion. He required the center of an epicycle to sweep out equal angles in equal times as viewed from the *center* of its associated deferent. Like the earth in the Ptolemaic

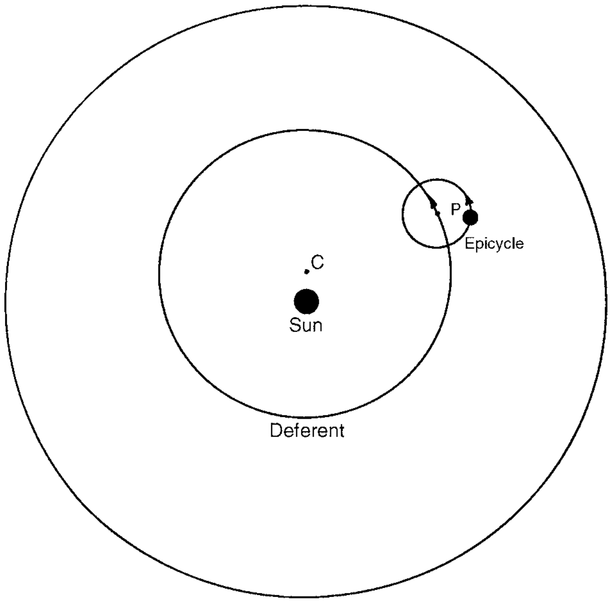

Figure 2.3. Copernican heliocentric model for a typical planet. Epicycles in the heliocentric model are much smaller than their counterparts in the geocentric model, and no equant points are allowed. The center of the Sun coincides with the center of the stellar sphere, but not with the center, C, of the planetary deferent.

models, the Sun is at the center of the fixed stellar sphere but not at the center of the deferent.[5]

Because Copernicus's book was highly technical, written for a small audience of mathematically proficient astronomers, it was little known and less read. Contrary to legend, its publication created no public stir. But the book *did* secure an audience among astronomers, many of whom employed it for calculating planetary positions, while denying its claim to cosmological truth.

Why did those astronomers who first mastered Copernicus's *Revolutions* refuse to accept the truth of heliocentrism? Because the evidence that could be marshaled in the middle of the sixteenth century in support of the heliocentric model as physically true was not convincing. No observation, taken by itself, could prove that the Sun rested and the earth moved. Predictions using the new system (in the form given it in the *Revolutions*) were no more accurate than those offered by the old.[6] The advantages of heliocentrism perceptible at the time were limited. First, elimination of the Ptolemaic equant meant that all motions were uniform about their centers—a feature of the heliocentric system viewed by some as a return to the proper foundational principles of astronomy. Second, Copernicus's lunar theory and his theory of the precession of the equinoxes were recognized as technically superior to Ptolemy's.

Third, the heliocentric system had a number of advantages that fall into the elusive realm of what we might call simplicity, order, coherence, or intelligibility. For example, the Ptolemaic system offered no obvious principle by which to determine the true sequence of the planetary orbits. Copernicus, working within a heliocentric framework, was able to argue that the planets are arranged in space, from innermost to outermost, according to their increasing periods of revolution about the Sun (fig. 2.4). He could also explain retrograde motion of the planets—the odd reversal of direction exhibited by the planets in their slow motion through the fixed stars. Predicted but unexplained by Ptolemy's geocentric astronomy, retrograde motion was revealed by heliocentrism to be a simple case of optical illusion, owing to the fact that we observe those planets from a moving platform (see fig. 2.5). Finally, the Ptolemaic model for every planet except the Moon (considered in this model to be the planet closest to the earth) contained some annual element: either the planet circled its epicycle annually, or the

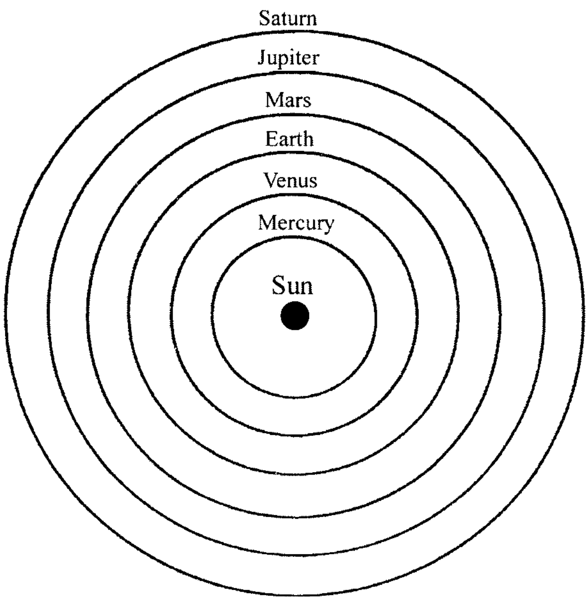

Figure 2.4. The order of the planets based on the heliocentric system (approximate orbital periods in parentheses). Proceeding outward from the Sun: Mercury (88 days), Venus (225 days), Earth (365 days), Mars (687 days), Jupiter (12 years), Saturn (30 years).

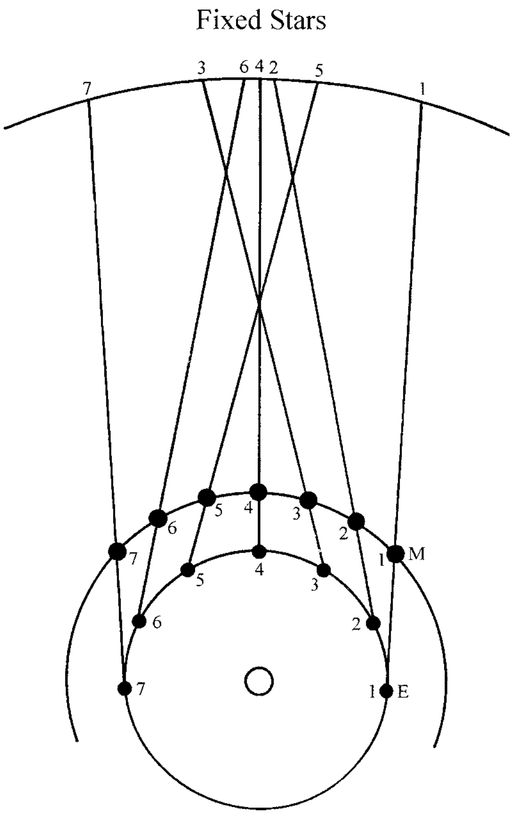

Figure 2.5. Retrograde motion of Mars explained on the heliocentric model. The position of Mars is observed at uniform intervals against the background of the fixed stars. Although both Mars (M) and the Earth (E) (from which Mars is observed) move with uniform motion, the line of sight in relation to the fixed stars (as indicated by the sequence of numbers at the top of the drawing) swings from right to left, then from left to right, then once again from right to left.

center of the epicycle circled the deferent annually. Inexplicable within a geocentric cosmology, these elements could be explained by a heliocentrist as the result of a simple perceptual error—the mistaken attribution to the observed bodies of motion actually possessed by the observer. Significant though such heliocentric advantages may seem in retrospect, none of them was widely regarded in the sixteenth century as decisive evidence of the truth of the heliocentric model. It was understood that such virtues as uniformity, simplicity, order, coherence, and intelligibility do not guarantee the truth of a theory; and before the end of the century respectable alternatives were available, to which one might be rationally committed.[7]

Alongside these advantages of the heliocentric model were several powerful disadvantages. First, putting the earth in motion represented a massive violation of everyday common sense. Second, removal of the earth from the center of the cosmos represented a destructive attack on Aristotle's physics—the only comprehensive system of physics in existence—and therefore represented a serious violation of scientific common sense. Third, to put the earth in motion was to put it into the heavens, thereby destroying the dichotomy between the heavens and the earth, which had served as a fundamental cosmological premise wherever Aristotelian philosophy prevailed for the previous two millennia. Fourth, the absence of stellar parallax (apparent change in the relative positions of a pair of stars, expected if those stars were viewed from a planet conceived to be moving through an orbit with a diameter of ten million miles) offered powerful empirical evidence against heliocentrism (fig. 2.6).[8] As a result, few people in the half century after publication of the *Revolutions* took the system seriously as a description of physical reality. Those astronomers and natural philosophers who rejected heliocentrism did so *not* because of blind conservatism or religious intolerance, but because of their commitment to widely held scientific principles and theories. Indeed, the first serious critics were young astronomers in the German universities, who perceived the simplicity and intelligibility of the heliocentric theory and used it for calculations, but regarded it as physically impossible. They understood that simplicity and intelligibility do not guarantee truth.[9]

From the Catholic church, a key player in our story, there was scarcely a stir. Copernicus had been talked into publishing his book by various friends, includ-

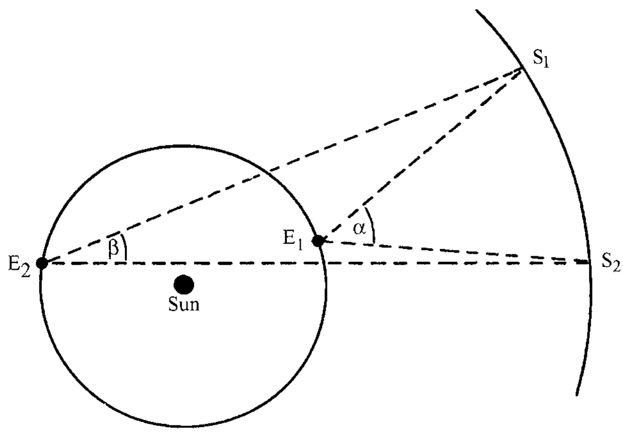

Figure 2.6. Stellar parallax on the heliocentric model. Suppose that the angular separation (α) between the two stars, S_1 and S_2, is measured from Earth in position E_1. Wait about six months, until Earth is in position E_2 (now judged, according to contemporary conceptions of the size of Earth's orbit, to be approximately ten million miles farther from the two stars). The angular separation (β) between the same two stars should now be substantially smaller. But in fact there is no measurable difference. It follows either that the stars are so unimaginably far away that ten million miles is infinitesimal by comparison or that the Earth is not in orbit around the Sun, but fixed in the center of the stellar sphere.

ing ecclesiastical officials. He had dedicated the *Revolutions* to the pope. And, except for one or two people, nobody judged his ideas dangerous—foolish, perhaps, but hardly a threat.

Galileo and Heliocentrism

The event that triggered Galileo's involvement in cosmological issues was the invention of the telescope by a Dutchman in the summer of 1608.[10] Galileo learned of it about a year later from his friend Paolo Sarpi and quickly figured out how to produce an eight-power version, later a twenty-power instrument. Equally important was his decision to turn the telescope to the heavens, converting a toy into an instrument of scientific investigation.

Galileo observed, successively, the fixed stars, the Moon, the planets, and eventually the Sun.[11] He saw previously invisible stars, thereby multiplying the population of the heavens roughly tenfold. He perceived craters, mountains, and valleys on the Moon (fig. 2.7). He discovered that the face of Venus passed through a complete set of phases, from thin crescent to full circular disk. Galileo observed four "little stars" accompanying Jupiter in its motion through the starry sphere, tagging along like dogs on a leash—stars that Galileo would

Figure 2.7. Galileo's sketch of the Moon as seen through the telescope. From Galileo's *Starry Messenger,* in *Le Opere di Galileo Galilei,* national ed., vol. 3, pt. 1 (Florence: Barbèra, 1892), p. 66.

identify, in his published account of these telescopic observations, as satellites. Saturn appeared to have "ears"—interpreted by Galileo as a pair of satellites accompanying the planet "on its flanks," but ultimately understood (after Galileo's death) as rings.[12] And finally, Galileo observed spots moving about on the surface of the Sun; he was not the first to do so and subsequently became involved in a bitter priority dispute over sunspots with the astronomer Christopher Scheiner.

Galileo apparently counted himself a Copernican from the mid-1590s; but it was the publication of an account of his telescopic observations in two small books, the *Starry Messenger* (1610) and *Letters on Sunspots* (1613), that propelled him into a serious heliocentric campaign. Galileo's telescopic observations certainly did not demonstrate the truth of the heliocentric model. However, they did, when deployed in his arguments, undermine some of the more powerful objections against heliocentric cosmology—a far cry from proving that heliocentric cosmology is true.

Consider several examples. What was the cosmological relevance of the discovery that the lunar surface is mountainous and pocked with craters? One of the most potent arguments against the mobility of the earth was the implausibility of the claim that this great earthen rock that we inhabit, the very symbol of stability, was sailing at breakneck speed through the heavens. But Galileo, armed with his lunar observations, argued that the Moon resembles the earth in topography (in the *Starry Messenger* he compares the lunar surface to that of Bohemia)[13] and therefore in substance; and the Moon sails through the heavens in all cosmologies. Consequently, it is illegitimate to deny the earth planetary status on grounds of its rocky substance. If this seems to us like a convincing proof, that is because we were convinced before we encountered the proof; to those who had grown up in a culture where the stability and centrality of the earth were reinforced every day in dozens of ways, the argument deriving from the appearance of the lunar surface would have appeared a great deal more problematic.

The argument from the satellites of Jupiter is of the same general type. In the reigning geocentric model of Aristotle and Ptolemy, the Moon is simply the planet situated closest to the central earth. When Copernicus removed the earth from the center, the Moon went along with it, for even the most basic lunar observations revealed that the Moon always has the same apparent diameter, from which it follows that the Moon has an earth-centered motion. The Moon thus obtained the status of satellite. Not only was it the only satellite in the planetary system (an ugly ad hoc feature of the heliocentric model, according to its critics), but it alone, among all the celestial bodies, circled about a center other than the stable center of the cosmos. However, if one accepted Galileo's discovery of Jupiter's satellites, then satellites and a center of celestial motions other than the center of the universe had to be acknowledged on any cosmology. Once again, an objection against heliocentric cosmology had been seriously weakened.

The phases of Venus gave rise to quite a different sort of argument. The standard geocentric model for the motion of Venus, devised by Ptolemy, predicted that Venus would never appear as a full circular disk (fig. 2.8).[14] If one believed Galileo's claim that the phases of Venus varied from thin crescent to full circle, the Ptolemaic model in its existing state was doomed.[15] However, it does not follow that *geocentrism* was doomed, for the geocentric model could be modified to accommodate Galileo's discovery. Indeed, the geocentric model already proposed and defended by the great Danish observational astronomer Tycho Brahe (1546–1601) predicted precisely what Galileo had discovered (fig. 2.9).[16] In short, although the observed phases of Venus were inconsistent with Ptolemy's specific model for Venus (and therefore probably offered rhetorical advantages to Galileo and other heliocentrists), they did not, if the matter were examined carefully, really tip the scales one way or the other in the geocentric-heliocentric debate. Galileo (eager to gain rhetorical advantage wherever he could) framed his argument in the *Letters on Sunspots* in such a way as to suggest that the phases of Venus, as he described them, defeated the only available geocentric model and consequently established the validity of Copernicus's heliocentric alternative "with absolute necessity."[17]

So Galileo had arguments, rather than proof. And in marshaling these arguments, he deployed his remarkable rhetorical gifts ("unexcelled in the annals of science," according to one modern historian of rhetoric).[18] Galileo's aim was not to write carefully reasoned scholarly papers of the sort astronomers and cosmologists now write, but to influence public opinion and win the cosmological

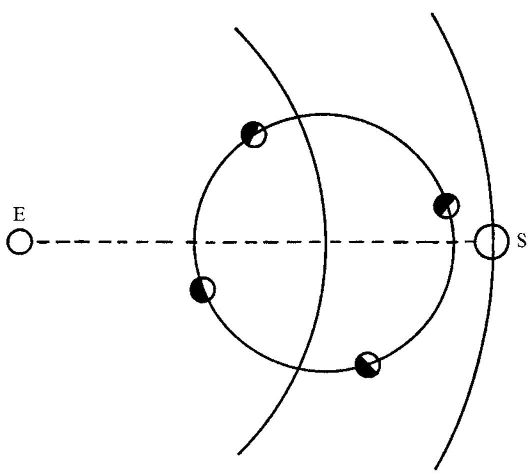

Figure 2.8. Ptolemy's model for Venus. Venus is shown in four different positions on its epicycle, the center of which is always situated on the line connecting Earth (E) and the Sun (S) (needed to guarantee that Venus will always appear close to the Sun). It is apparent that the illuminated half of Venus always directly faces the Sun and, therefore, faces mostly away from Earth. It follows that if this model describes the real world, terrestrial observers will never see more than a thin crescent of Venus.

debate in the public arena.[19] His arguments were as notable for their emotional power as for their logical power. The *Starry Messenger,* with which Galileo's campaign began, was written in Latin and therefore clearly intended for the highly educated. However, the audience that Galileo had in mind was much broader than Copernicus's audience of astronomical specialists; this book (like all of Galileo's cosmological publications) contained no mathematics and no astronomical technicalities and was meant for anybody capable of reading Latin.

Opening Confrontations

But why did Galileo run into trouble? Why did he encounter opposition, whereas seventy years earlier heliocentrism had caused no stir? Because in those seventy years the climate of opinion within the Catholic church had changed. This changed climate, to put it in simplest terms, was a result of the Protestant Reformation—a broad reform movement within the Catholic church, which reached its climax in the first half of the sixteenth century and culminated in the

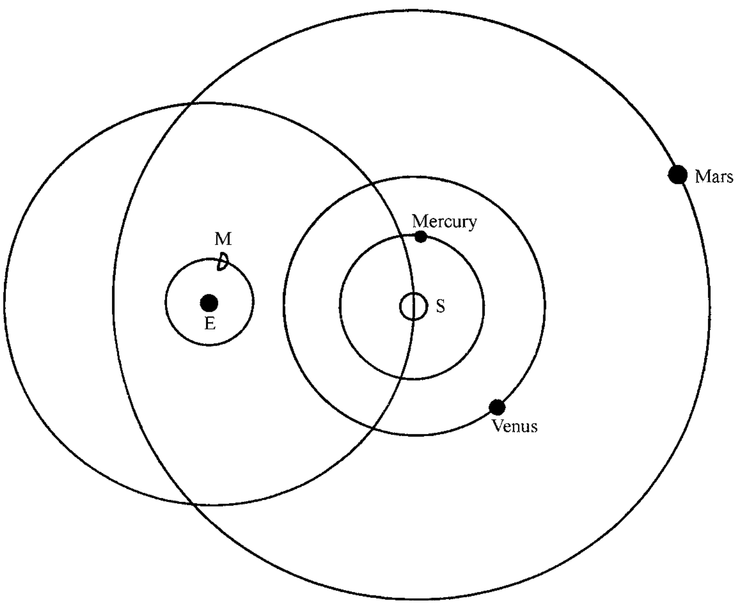

Figure 2.9. The geo-heliocentric cosmology of Tycho Brahe. Earth (E) is situated at the center of the stellar sphere (not shown). The Sun (S) and Moon (M) orbit Earth. The remaining planets are satellites of the Sun, accompanying it in its annual course through the fixed stars, while orbiting it, each with its characteristic period. Jupiter and Saturn, not shown, also have Sun-centered motions.

splitting of Western Europe roughly into Protestant and Catholic halves.[20] Naturally, the leaders of the Catholic church reacted to such a catastrophic event: having just lost half of Europe as a result of what could be construed as a relaxed policy toward dissent and controversy, they turned cautious. Driven by principles that emerged from the Council of Trent (1545–63), they took giant steps toward converting the church into a centralized, authoritarian bureaucracy capable of enforcing orthodox belief. This church bureaucracy was a great deal more worried about controversy than the medieval church had been. And it took a much stricter view of biblical interpretation, moving (in the years after Trent) toward literalism and refusing to embrace any interpretation not sanctioned by church tradition or the church fathers. A decree on the interpretation of Scripture that emerged from the council reads:

> The Council decrees that, in matters of faith and morals . . ., no one, relying on his own judgment and distorting the Sacred Scriptures according to his own conceptions, shall dare to interpret them contrary to that sense which Holy Mother Church, to whom it belongs to judge their true sense and meaning, has held and does hold, or even contrary to the unanimous agreement of the Fathers.[21]

This emphatic statement was a repudiation of the Protestant notion that Scripture stands alone as the proper authority for Christian belief and practice, in no way dependent on church tradition.

Galileo's troubles began soon after publication of the *Starry Messenger*.[22] In 1611, he made a visit to Rome to plead the case for his telescopic discoveries in person. The Jesuits at the Collegio Romano confirmed his telescopic observations (but not the heliocentric interpretation that he gave them) and treated him as a celebrity.[23] However, back in Florence Galileo's attempt to press the case for heliocentrism was beginning to run into opposition. Cosmology had always been a moderately sensitive issue, and the Giordano Bruno affair ten years earlier had perhaps increased the danger.[24] By posing a threat to the literal sense of certain scriptural passages, heliocentrism became a concern around which opposition to Galileo among conservative Florentine Dominicans could coalesce. Three years later, controversy over sunspots between Galileo and the Jesuit astronomer Christopher Scheiner resulted in a cooling of relations between Galileo and his Jesuit friends and supporters.

About the same time, Galileo got caught up in a debate regarding the possible mobility of the earth that had begun during a breakfast at the Medici court (reported to Galileo by his friend and student, Benedetto Castelli). Particularly worrisome for Galileo and his cosmological campaign was the extent to which the participants in this debate had been prepared to decide the issue by appeal to Scripture. There was clearly a need, Galileo perceived, for a sophisticated discussion of the principles of interpretation (or exegesis) applicable to the allegedly scientific content in Scripture. Galileo sought to supply this discussion in an open letter to Castelli—a handwritten letter that was soon circulating in multiple copies. Galileo argued in this letter that the sole purpose of the Bible was to persuade readers "of those articles and propositions which are necessary for . . . salvation and surpass all human reason." When the biblical text oversteps those limits, addressing matters that are within reach of sensory experience and rational knowledge, God does not expect these God-given capacities to be abandoned. In order to be widely understood, the scriptural writers accommodated themselves to popular conceptions; consequently, in matters of scientific dispute, the interpreter need not be limited to the "apparent meaning of the words."[25] It follows that theologians, before committing themselves to an interpretation of such passages, would be well advised to examine the demonstrative arguments of scientists or natural philosophers.

Galileo had embarked on a dangerous course. In this letter (subsequently expanded and published as the *Letter to the Grand Duchess Christina*), Galileo articulated principles of biblical interpretation emanating from Augustine (354–430) and long accepted within organized Christendom.[26] Nevertheless, advice from a layman on such matters was not welcomed by the theologians and other officials who staffed the church bureaucracy, particularly when that advice ran (in its willingness to push aside the opinion of the church fathers, as well as the literal sense of Scripture) so obviously against prevailing exegetical opinion as it had developed within the church since Trent.

Galileo's letter provoked a strong reaction, still largely local. The bishop of Fiesole (a hill town just outside Florence) called for the jailing of Copernicus.[27] The bishop was unaware that Copernicus had been dead for seventy years; he knew only that this Copernicus was a menace and should be kept off the streets. A little later, an elderly member of the Dominican order, Niccolò Lorini, secured a copy of Galileo's letter to Castelli and sent it to the Inquisition (the bureau in Rome responsible for ensuring correct belief and dealing with matters of heresy, also known as the "Holy Office"). In his cover letter, Lorini accused Galileo of adopting rash and possibly heretical principles of biblical exegesis.[28]

Galileo had no knowledge of this specific accusation, but he was aware that trouble was brewing and decided that he must go to Rome once more to make his case personally within the halls of power. He was convinced that he had decisive scientific arguments, and he naïvely supposed that such arguments would carry him to victory over the geocentric opposition. Moreover, memories of that triumphant visit to Rome a few years earlier encouraged optimism. Once in Rome (late 1615 and early 1616), Galileo cut quite a figure, arguing his case with passion wherever opportunity presented itself. A certain Antonio Querengo has left a vivid account of Galileo's persuasive efforts:

> He discourses often amid fifteen or twenty guests who make hot assaults upon him, now in one house, now in another. But he is so well prepared that he laughs them off; and although the novelty of his opinion leaves people unpersuaded, yet he reveals the futility of most of the arguments with which his opponents try to defeat him. Monday, . . . in the house of Federico Ghislieri, he achieved wonderful feats; and what I liked most was that, before answering the opposing arguments, he amplified and strengthened them with new grounds that appeared invincible, so that, in subsequently demolishing them, he made his opponents look all the more ridiculous.[29]

The Florentine ambassador to Rome, whose obligation it was to protect Galileo, was not pleased. Reporting to the grand duke of Tuscany, he wrote that Galileo "is vehement and stubborn and very worked up in this matter; and it is impossible, when he is around, to escape from his hands. And this business is not a joke, but may become of great consequence, and the man [Galileo] is here under our protection and responsibility."[30]

Galileo received plenty of attention, but he did not convince the people who counted (though he certainly had his supporters). His arrogant, impetuous style seems, on balance, to have been more effective in stirring up trouble and making enemies than (as he had hoped) in calming the waters. Indeed, near the end of February 1616, while Galileo was still in Rome, the Inquisition, finally acting on the charges made several years earlier by Lorini, censured two propositions that embodied the essentials of the heliocentric system: that the Sun is at rest in the center of the universe, and that the earth is in motion around it. The consultors to the Inquisition declared these propositions to be "philosophically absurd" and either "formally heretical" (the former proposition) or "at least erroneous in faith" (the latter). The published decree placed Copernicus's *Revolutions* on the Index of Prohibited Books "until corrected."[31] There it remained until 1835.

What lay behind this decision of the Inquisition? In simplest and specific terms, the question was whether or not the heliocentric hypothesis is consistent with traditional church teachings (based on a literal reading of biblical passages that appear to address, directly or indirectly, cosmological matters). The larger issue that lay behind this question was that of epistemological authority: are cosmological truth-claims dependent on science or on theology—on conclusions drawn from reason and sense experience or on the content of biblical revelation as interpreted by the fathers of the church? And if both are to be taken into account, how are competing cosmological and theological claims to be adjudicated? Reason and sense, Galileo claimed, taught the mobility of the earth. But revelation literally interpreted, said the leading theologians, clearly taught its fixity. Half a dozen passages from the Bible were appealed to by the theologians. Two of them speak to the issue with particular clarity:

> Ecclesiastes 1:5: The Sun rises and the Sun goes down, and hastens to the place where it rises.
>
> Psalm 93:1: . . . the world [i.e., the earth] is established; it shall never be moved.

These are manifestly expressions of geocentric cosmology. A third passage also yields easily to a geocentric interpretation:

> Joshua 10:12–13: Then spoke Joshua to the Lord in the day when the Lord gave the Amorites over to the men of Israel; and he said in the sight of Israel, "Sun, stand thou still at Gibeon, and thou Moon in the valley of Aijalon." And the Sun stood still, and the Moon stayed, until the nation took vengeance on their enemies.

Note that Joshua commanded the Sun to stop, in violation of what was obviously its natural state of motion. Were the cosmos heliocentric, Joshua would have been obliged to command the earth to cease rotation on its axis.

Added to these biblical texts was a further epistemological consideration. It was widely held by leading theologians, both Catholic and Protestant, that the natural sciences were in principle incapable of determining the true world system with certainty. Only the Creator knows what lies behind the celestial motions; the human intellect has no access to this divine knowledge. We cannot climb up into the heavens to find out what is really going on; and the kind of evidence we can gather from our terrestrial vantage point simply does not settle the matter. The same lesson was taught by the Ptolemaic astronomical tradition, which had been dominated by strong "instrumentalist" tendencies—treating the mathematical models for the planets as mere mathematical instruments, designed to predict observed planetary positions but not to describe celestial reality.

Given these arguments, what would the balance sheet have looked like to members of the Inquisition? On the side of geocentric cosmology were clear biblical statements to the effect that the Sun moves, while the earth is fixed. In support of heliocentric cosmology were no scientific proofs, but scientific opinions and arguments, asserted within a climate that cast doubt on the ability of the human intellect ever to discover the true cosmological system. Thus it was not (as members of the Inquisition saw it) divinely inspired biblical certainties against convincing scientific demonstrations, but biblical certainties against improbable scientific conjectures. From the church's perspective, no choice could have been easier.

It is tempting, from a modern perspective, to propose that the leading theologians of the church ought to have modified their interpretation of the relevant biblical texts in order to get into step with scientific opinion. But we must keep in mind that the position adopted by the Inquisition *was* in step with the majority, if not the latest, scientific opinion. And it would have been a most remarkable event had its members taken elaborate measures to abandon their own deeply held principles of biblical interpretation, as well as the traditional cosmological opinions of the church fathers, while simultaneously rejecting the majority opinion of qualified astronomers.

Let us return briefly to the course of events. The Inquisition formally censured heliocentrism in 1616, declaring it false and heretical. But Galileo faced no personal danger. He was charged with no offense; he was not declared a heretic. He was simply summoned by Cardinal Roberto Bellarmino, representing the Inquisition, and informed that heliocentrism had been declared false and heretical and was not to be held or defended. A surviving affidavit issued by Bellarmino states that Galileo had

> been notified of the declarations made by the Holy Father and published by the Sacred Congregation of the Index, whose content is that the doctrine attributed to Copernicus (that the earth moves around the sun and the sun stands at the center of the world without moving from east to west) is contrary to Holy Scripture and therefore cannot be defended or held.[32]

However, the Galileo file of the Inquisition contains another document that has figured prominently in the story of the Galileo affair. This document, a memorandum dated 26 February 1616, asserts that the meeting between Galileo and Bellarmino was also attended by the commissary general of the Inquisition, Angelo Segizzi, who ordered Galileo "to abandon completely the . . . opinion that the sun stands still at the center of the world and the earth moves, and henceforth not to hold, teach, or defend it in any way, either orally or in writing."[33] The importance of this document, if authentic, is that the order issued by Segizzi, forbidding all discussion of heliocentrism, went subtly but significantly beyond the command issued by Bellarmino, which merely enjoined Galileo not to "defend or hold" (as true) the heliocentric hypothesis. But is the document authentic? Probably, although the contrary opinion has also been vigorously defended.[34] Either way, it found its way into the Inquisition's file on Galileo; there it remained, waiting to be used against Galileo in the trial of 1633.

The decree of 1616 brought Galileo's public campaign on behalf of heliocentrism to a halt. Galileo returned to Florence, where he turned, of necessity, to the pursuit of other scientific interests. Toward the end of 1618 three comets passed through the European skies in quick succession. These comets caused considerable excitement and elicited a certain amount of commentary on the nature of comets, including attempts to extract from the phenomena of comets conclusive arguments against heliocentrism. Galileo was drawn into controversy with a Jesuit mathematics professor, Orazio Grassi, who had written on the subject; and the two were soon attacking each other in pseudonymous treatises and through intermediaries. The controversy culminated in Galileo's publication of a treatise, *The Assayer* (1623)—among other things, a bitter attack on Grassi, in which Galileo accused him of rude behavior, fraud, and intellectual theft.[35] *The Assayer* set forth the foundations of a mechanistic account of nature and later emerged as a landmark in the development of seventeenth-century science; but its importance for Galileo and heliocentrism lay in the poisoning of the waters between Galileo and the Jesuits, with whom Galileo had managed, until now, to maintain friendly relations.

Dialogue Concerning the Two Chief World Systems

Paul V, pope during the first decades of Galileo's heliocentric campaign, died in 1621. After the two-year papacy of Gregory XV, Maffeo Barberini (descended from a wealthy Florentine family) ascended to the papal throne as Urban VIII. Urban was considered an intellectual, a man of vision, and a moderate on the subject of heliocentrism. Moreover, he was an admirer and friend of Galileo. Three years earlier he had written a poem honoring Galileo for some of his telescopic discoveries; and just six weeks before his election to the papacy, he had thanked Galileo for the latter's congratulatory letter sent in acknowledgment of a doctorate received by the future pope's nephew. "I remain much obliged to Your Lordship," Barberini wrote, "for your continued affection towards me and mine"; and he assured Galileo "that you will find in me a very ready disposition to serve you out of respect for what you so merit and for the gratitude I owe you."[36]

The election of his friend Barberini to the papacy must have seemed to

Galileo an incredible stroke of luck. Galileo quickly concluded that he must exploit these changed circumstances in an attempt to revive the battle for heliocentrism. He requested an audience with the pope. In the course of six meetings, the two got around to the subject of cosmology. Urban made clear his belief that humans were, in principle, incapable of achieving certainty regarding cosmological matters. To develop a model that would make accurate astronomical predictions, he argued, was not to prove the truth of that model; and on that point, of course, he was perfectly correct, both in his terms and in ours. According to a report from one of Urban's confidants of a conversation between Urban and Galileo (perhaps during one of these audiences), Urban argued:

> Let us grant you that all of your demonstrations are sound and that it is entirely possible for things to stand as you say. But now tell us, do you really maintain that God could not have wished or known how to move the heavens and the stars in some other way? [Urban assumes that Galileo concedes the point.] Then you will have to concede to us that God can, conceivably, have arranged things in an entirely different manner, while yet bringing about the effects that we see. And if this possibility exists, which might still preserve in their literal truth the sayings of Scripture, it is not for us mortals to try to force those holy words to mean what to us, from here, may appear to be the situation.[37]

Nonetheless, from his discussions with the pope, Galileo came to understand that he was free to write about heliocentrism, so long as he treated it as mere hypothesis. Although Galileo was forbidden by the decree of 1616 to defend heliocentrism as true, there could be no objection to a treatise that explored the pros and cons of the heliocentric model.

Galileo set to work, completing his *Dialogue on the Two Chief World Systems* in 1629, after several delays owing to illness. His goal, no doubt, was to treat heliocentrism as a hypothesis, in accordance with Urban's admonition, but in the process to demonstrate unmistakably that it was the *best* hypothesis available. As the book emerged from his pen, however, it had become nothing less than a powerful argument on behalf of the indubitable *truth* of heliocentrism; no reader could have understood it otherwise. Nor did one have to read between the lines to perceive this as Galileo's purpose, for in the *Dialogue* itself he repeatedly claimed to have demonstrated the "truth" of his conclusions.[38]

In the *Dialogue,* Galileo skillfully refuted the standard objections against heliocentrism—the claim, for example, that on a moving earth a heavy object dropped from a tower would not strike the ground at the foot of the tower. On the positive side of the ledger, he pointed to such advantages of heliocentrism as its superior ability to explain retrograde motion. Crucial to his positive case was an argument from the tides, which claimed that the only adequate explanation of the tides was to see them as the sloshing of water in the great sea basins owing to the double motion of the earth (annual about the Sun and daily on its axis). At the close of the four days of dialogue, after bombarding his readers with arguments in favor of heliocentrism, Galileo had his mouthpiece, Salviati, disclaim belief in the truth of heliocentrism, portraying it as a fancy, a chimera, or a paradox, intended only to display the physical arguments on behalf of heliocentrism without any claim of physical truth. "I do not ask and have not asked from others," Salviati states, "an assent which I myself do not give to this fancy, and I could very easily regard it as a most unreal chimera and a most solemn paradox."[39] Simplicio (who had staunchly defended traditional Aristotelian geocentric cosmology throughout the dialogue) responds:

> I confess that your idea [of explaining the tides on the heliocentric model] seems to me much more ingenious than any others I have heard, but I do not thereby regard it as true and convincing. Indeed, I always keep before my mind's eye a very firm doctrine, which I once learned from a man of great knowledge and eminence, and before which one must give pause. From it I know what you would answer if . . . you are asked whether God with His infinite power and wisdom could give to the element water the back and forth motion we see in it by some means other than by moving the containing basin; I say you will answer that He would have the power and the knowledge to do this in many ways, some of them even inconceivable by our intellect. Thus, I immediately conclude that in view of this it would be excessively bold if someone should want to limit and compel divine power and wisdom to a particular fancy of his.[40]

The close resemblance between this speech, emanating from a "man of great knowledge and eminence," and the pope's argument, quoted above, is unmistakable. That Galileo put it into the mouth of the slow-witted Aristotelian laughingstock of the dialogue did not escape Urban's notice.

Galileo submitted the book through the appropriate channels for licensing by the church. Father Niccolò Riccardi, whose responsibility it was to make the final decision on suitability for publication, understood the delicacy of the subject matter and worried about Galileo's manuscript. He knew that Urban had granted Galileo permission to publish a book on the subject of cosmology, but he wasn't certain that this was the book the pope had had in mind. After several long delays and various revisions, including a new preface and conclusion expressly written to make clear that heliocentrism was no more than a hypothesis, Riccardi granted the official imprimatur.[41] The book, written in Italian (thereby violating contemporary scholarly custom in an attempt to reach the broadest possible lay readership), was printed in Florence and appeared in bookshops in February 1632.

The Trial and Recantation

To appreciate the reception of Galileo's *Dialogue* at the papal court, we need to understand the tense circumstances then prevailing in Rome, which had become a hotbed of fear and suspicion.[42] Europe was midway through the Thirty Years' War; the power of the papacy was threatened by the Spanish, who controlled half of the Italian peninsula; and the pope himself had recently come under heavy criticism for adopting positions of political expediency apparently favorable to the Protestant king Gustavus Adolphus of Sweden. On top of everything else, a horoscopic prediction of Urban's imminent death began to circulate, falsely rumored to have come from Galileo's hand. Under the circumstances, whatever equanimity Urban may have possessed dissolved into irritability, mistrust, and authoritarian behavior; it was not a propitious moment for the appearance of a book by this same Galileo on the theologically sensitive topic of cosmology.

Urban quickly discovered (perhaps with help from Galileo's enemies) his argument in the mouth of Simplicio. He became convinced that Galileo had brazenly ignored his admonition about the hypothetical character of heliocentrism and, moreover, by choosing to have his argument voiced by the inept Simplicio, had knowingly made the pope an object of ridicule. Such flagrant insubordination could not go unpunished. A letter from the Florentine ambassador, Francesco Niccolini, to his superior in Florence reveals the pope's state of mind:

> Yesterday I did not have time to report to Your Most Illustrious Lordship what had transpired (in a very emotional atmosphere) between myself and the Pope in regard to Mr. Galilei's work. . . . I too am beginning to believe, as Your Most Illustrious Lordship well expresses it, that the sky is about to fall. While we [Niccolini and Urban] were discussing those delicate subjects of the Holy Office, His Holiness exploded into great anger, and suddenly he told me that even our Galilei had dared entering where he should not have, into the most serious and dangerous subjects which could be stirred up at this time. I replied that

> Mr. Galilei had not published without the approval of his ministers and that for that purpose I myself had obtained and sent the prefaces to your city. He answered, with the same outburst of rage, that he had been deceived by Galileo.

Niccolini added later in the letter, "Thus I had an unpleasant meeting, and I feel the Pope could not have a worse disposition toward our poor Mr. Galilei." In another letter, written six days later, Niccolini reported: "the Pope believes that the Faith is facing many dangers and that we are not dealing with mathematical subjects here but with Holy Scripture, religion, and Faith."[43]

It was inevitable, under the circumstances, that the judicial machinery of the Inquisition would be set in motion. Printing of Galileo's *Dialogue* was immediately suspended. The pope appointed a special commission to investigate the case, charging it to weigh "every smallest detail, word for word, since one is dealing with the most perverse subject one could ever come across."[44] An alarmed Galileo, informed by friends of developments in Rome, sought to ameliorate the situation through the intervention of the Florentine ambassador and others favorable to his cause. The latter group included some of the very officials involved in the proceedings against Galileo, for the papal court could not claim perfect uniformity of thought. In the end Galileo (now nearly sixty-nine years old and in poor health) was compelled to make the long trip (about two hundred miles) from Florence to Rome for interrogation and trial. Traveling in a coach provided by his patron, the grand duke of Tuscany, Galileo left Florence toward the end of January 1633 and (after a period of quarantine at the border between Tuscany and the Papal States, required by fear of plague) arrived in Rome three weeks later. There he was comfortably housed, first in the residence of the Florentine ambassador, subsequently (during the actual trial) in a suite of rooms provided by the Inquisition, attended by his own servant.[45]

As the case unfolded in the course of the trial, it proved to be only indirectly about biblical interpretation and cosmological theories (as was the decision of 1616 condemning heliocentrism).[46] The trial of 1633 was about disobedience and flagrant insubordination: the issues dealt with in the decree of 1616 were not reexamined; its conclusions were merely reasserted.[47] The memorandum of 26 February 1616 was discovered in the Inquisition's file on Galileo, and its broader prohibition was used to seal the case against Galileo—to prove beyond the shadow of a doubt that he had disobeyed orders issued by the Inquisition. Even without this disputed memorandum, however, Galileo's disobedience, and therefore his guilt, would surely have been clear to everybody.

In the course of the trial, which began in the middle of April, Galileo was given the opportunity to make a statement. He revealed that since the previous interrogation he had been thinking continuously about the charge in the 1616 memorandum that had forbidden him to "hold, teach, or defend" heliocentrism in any manner whatsoever. "It occurred to me," he added,

> to reread my published *Dialogue,* which I had not seen for three years, in order carefully to ascertain whether, contrary to my most sincere intention, there had inadvertently fallen from my pen anything from which a reader or the authorities might infer . . . some sign of disobedience on my part. . . . I was able to obtain a copy of my book. . . . And, because I had not seen it for so long, it seemed to me like a new writing and by another author. I freely confess that it seemed to me composed in such a way that a reader ignorant of my real purpose might have reason to think that the arguments presented for the false side, which I really intended to refute, were expressed in such a way as to . . . compel conviction . . . rather than to be easily refuted.[48]

It was a nice try, but it would not do the job. As for Segizzi's injunction, described in the memorandum of 1616, Galileo claimed to have no recollection of it and therefore to have had no intention to deceive the Inquisition when he failed to mention it in the course of his application for the licensing of his book.[49]

The case dragged on into the second half of June. On 21 June, Galileo was summoned and asked "whether he holds or has held, and for how long, that the Sun is the center of the world and the earth is not the center of the world but moves with a daily motion." In his now famous recantation, Galileo replied:

> A long time ago, . . . before the decision of the Holy Congregation of the Index, and before I was issued that injunction, I was undecided and regarded the two opinions, those of Ptolemy and Copernicus, as disputable, because either the one or the other could be true in nature. But after the above-mentioned decision, . . . all my uncertainty vanished, and I held, as I still hold, as very true and undoubted, Ptolemy's opinion, namely, the stability of the earth and the motion of the sun.[50]

Sentence was passed the next day:

> We say, pronounce, sentence, and declare that you, the above-mentioned Galileo, because of the things deduced in the trial and confessed by you . . . , have rendered yourself . . . vehemently suspected of heresy, namely, of having held and believed a doctrine that is false and contrary to the divine and Holy Scripture: that the sun is the center of the world and does not move from east to west, that the earth moves and is not the center of the

> world, and that one may hold and defend as probable an opinion after it has been declared and defined as contrary to Holy Scripture.

The sentencing document proceeded to condemn Galileo "to formal imprisonment in this Holy Office at our pleasure. As a salutary penance we impose on you to recite the seven penitential Psalms once a week for the next three years. And we reserve the authority to moderate, change, or condone wholly or in part the above-mentioned penalties and penances."[51] Galileo's imprisonment was subsequently commuted to house arrest.

As a final event in this tragedy, Galileo was required to "abjure" his error—that is, to renounce it under oath. Kneeling in the Dominican convent of Santa Maria sopra Minerva, he said:

> I, Galileo, son of the late Vincenzio Galilei of Florence, . . . having before my eyes and touching with my hands the Holy Gospels, swear that I have always believed, I believe now, and with God's help will believe in the future all that the Holy Catholic and Apostolic Church holds, preaches, and teaches. However, whereas, after having been judicially instructed with injunction by the Holy Office to abandon completely the false opinion that the sun is the center of the world and does not move, and that the earth is not the center of the world and does move, and not to hold, defend, or teach this false doctrine in any way whatever, orally or in writing; and after having been notified that this doctrine is contrary to Holy Scripture, I wrote and published a book in which I treat of this already condemned doctrine and adduce very effective reasons in its favor, without refuting them in any way; therefore, I have been judged vehemently suspected of heresy. . . .
>
> Therefore, desiring to remove from the minds of Your Eminences and every faithful Christian this vehement suspicion, rightly conceived against me, with a sincere heart and unfeigned faith I abjure, curse, and detest the above-mentioned errors and heresies, and in general each and every other error, heresy, and sect contrary to the Holy Church; and I swear that in the future I will never again say or assert, orally or in writing, anything which might cause a similar suspicion about me; on the contrary, if I should come to know any heretic or anyone suspected of heresy, I will denounce him to this Holy Office.[52]

The abjuration was a formality, of course. It is foolish to accuse Galileo, as some have done, of selling out in the battle for freedom of thought and expression. No such battle existed in early seventeenth-century Italy; and if there had been one, it is doubtful that Galileo would have joined it. The significance of Galileo's condemnation and abjuration is simply the humiliation of Italy's greatest living scientist and the end of his campaign on behalf of heliocentrism.

For the remaining nine years of his life, Galileo was under house arrest, comfortably situated in his rented villa just outside Florence, with few restrictions on who could come and go. He turned his attention to other scientific problems, principally mechanics and the strength of materials, preparing the manuscript that was to be published in the Netherlands as the *Discourse on Two New Sciences* (1638). As punishment for his defense of heliocentrism, Galileo suffered neither torture nor imprisonment. But he lost his freedom of movement and, perhaps most important of all, his voice on the subject of cosmology.

Conclusions

Is this merely a story of heroic and not-so-heroic deeds leading to a tragic end, or can it teach us something about the historical relations of science and religion? There are, indeed, important lessons to be learned from the Galileo affair, but not the ones customarily drawn.

First, the Galileo affair is often presented as a simple ideological conflict: scientific rationalism versus religious authority. But as we have seen, it had an enormous human and political dimension as well. Science and religion as such cannot interact, but scientists and theologians can. Theoretical and methodological positions come down to earth and enter the real world only insofar as they are defended by humans; and when flesh and blood make an appearance, we are apt to find that personal interest and political ambition are as important as ideological stance. There were old scores to settle, egos to stroke, and careers to be made. Dominican-Jesuit politics clearly figured in the drama.[53] Galileo's friendship with members of the pro-Spanish faction at the papal court may also have played a role, as did his alienation of the Jesuits and his apparent betrayal of the pope. Galileo's personality was a consistent and important factor; indeed, it seems clear that had he played his cards differently, with more attention to diplomacy, Galileo might well have carried out a significant campaign on behalf of heliocentrism without condemnation.

It follows, in the second place, that the outcome of the Galileo affair was powerfully influenced by local circumstances. The Galileo affair was not merely about universal or global aspects of science and religion, or universal beliefs of scientists and religious leaders, but also (as we have seen) about the local circumstances impinging on individual historical actors—fears, rivalries, ambitions, personalities, political context, and socioeconomic circumstance. Historical events are situated in time and space; they are contingent and local, and our analysis must respond to this reality.

Third, the Galileo affair is consistently and simplistically portrayed as a battle between science and Christianity—an episode in the long warfare of science and theology. This is how Andrew Dickson White viewed the matter in the nineteenth century, and his interpretation has become part of the Western cultural heritage. But consider the complex reality. Every one of the combatants, whether church official or disciple of Galileo, called himself a Christian; and all, without exception, acknowledged the authority of the Bible. Many on both sides of the struggle, including Galileo, were theologically informed, capable of articulating carefully reasoned theological positions. Similarly, all of the principal combatants, from Urban VIII to Galileo and his supporters (even Grand Duchess Christina, on the sidelines), possessed informed, rationally defensible, and strongly held cosmological beliefs.

But the complexity does not end here. Among the clergy, differences of opinion regarding principles of biblical interpretation were tolerated; and some clergy, adopting Galileo's exegetical principles, counted themselves among his vocal supporters. Meanwhile, among people with special expertise in astronomy and cosmology, heliocentrism (viewed as an account of cosmological reality) remained a minority opinion. It follows that conflict was located as much *within* the church (between opposing theories of biblical interpretation) and *within* science (between alternative cosmologies) as *between* science and the church. This analysis is an attempt not to downplay the magnitude or seriousness of the conflict over heliocentrism, but simply to map it. And the point is that it is impossible to identify clearly defined battle lines falling along a divide separating heliocentric scientists, prepared to overlook the Bible or interpret it allegorically, from geocentric theologians or clergy, committed to church tradition and biblical literalism.

There remained, of course, the problem of epistemological authority—whether the truth of cosmological claims was to be determined by exercise of the human capacities of sense and reason, by appeal to biblical revelation, or by some combination of the two. This was the central methodological issue in the Galileo affair, and we must not allow our enthusiasm for the local and human aspects of the struggle to obscure it. That the position adopted by church officials in the Galileo affair was not an *inevitable* accompaniment of Christian belief is clear from the fact that Christians of all stripes are now heliocentrists; and many Christians, both Catholics and Protestants, were heliocentrists in the seventeenth century. But we must also recognize that the issue of epistemological authority in areas of overlap (actual or potential) between the Bible and the natural sciences remains unresolved for some Christians to this day, as we see in contemporary battles between "creationists" and "evolutionists." This lack of resolution means that tension and the potential for conflict will continue to hover over the relationship between Christianity and science.

Finally, how shall we judge the protagonists in the Galileo affair? Making such judgments is not the historian's main business. However, I believe that we can learn something important from the exercise if we proceed with due caution. In order to avoid making a complete mess of the matter, we need to be aware of whose values we are employing—those that prevail in modern democracies at the beginning of the third millennium, or those that prevailed in Catholic Europe almost four hundred years ago, in the first third of the seventeenth century. Let us try it each way.

Viewing the church's apparatus for suppression of dissent, its police power, its threat of torture (indeed threat of burning at the stake for a heretic who refused to recant), we who live in modern democracies will surely be inclined to judge harshly. There are certainly modern examples of the attempt to impose theological censorship on scientific beliefs; but they are exceptional. And the belief that such censorship should be imposed under threat of burning at the stake is no longer, to my knowledge, a common approach to the problem. There is no question that such a comparison of cultures (theirs with ours) stands to teach us interesting and useful lessons; though if we merely use this exercise as an occasion for condemning seventeenth-century Italians for not being modern Europeans or Americans, the effort has been wasted.

But the interesting and informative judgment for a historian is one that evaluates early seventeenth-century actions not by modern values but by standards of civilized behavior widely or universally subscribed to by early seventeenth-century people. Judged in these terms, the Galileo affair takes on quite a different appearance. The early seventeenth century was a time of growing absolutism in Europe, in both the religious and political realms. The freedom to express dangerous ideas was as unlikely to be defended in Protestant Geneva as in Catholic Rome. The idea that a stable society could be built on general principles of free speech was defended by nobody at the time; and police and judicial constraints were therefore inevitable realities.

Measured against such contemporary norms and values, the proceedings against Galileo were not faultless: for example, identification of cosmological claims as "matters of faith and morals," if consistent with the biblical literalism that emerged after the Council of Trent, certainly ran against the grain of older exegetical principles, articulated in the writings of Augustine and Aquinas. There were also procedural irregularities. By and large, however, the central bureaucracy of the church and the people who staffed it lived up to widely held norms, followed accepted procedure, and even on a number of occasions treated Galileo with generosity. Had these troubles befallen somebody other than himself, it is doubtful that Galileo would have found the inquisitorial procedures objectionable. He objected not to the right of the church to enter the cosmological debate, but rather to the position it adopted in that debate. In short, examined in seventeenth-century terms, the outcome of the Galileo affair was a product not of dogmatism or intolerance beyond the norm, but of a combination of more or less standard (for the seventeenth century) bureaucratic procedure, plausible (if ultimately flawed) political judgment, and a familiar array of human foibles and failings.

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