Journal of Religion & Society

Volume 1 (1999)
ISSN 1522-5658

Galileo and the Inquisition[1]

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Abstract

The story of Galileo's encounter with the Inquisition in the early 17th Century continues to be an important part of the story of modernity. Galileo is frequently seen as breaking with the scientific heritage of Aristotle to found a new science of nature and, in the process, he also had to do battle with an entrenched biblical literalism in the Catholic Church. According to the generally accepted view, Galileo's break with both Aristotle and the Inquisition is a founding feature of modern culture. This essay challenges such a view and argues that Galileo's science, at least in its principles, is Aristotelian in inspiration, and that Galileo and the theologians of the Inquisition shared first principles concerning both the complementarity of faith and reason as well as the authority of the Church to be the authentic interpreter of the truths of scripture. In fact, the controversy between Galileo and the Inquisition would be unintelligible were it not the case that all parties shared common first principles.

Introduction

[1] On the occasion of the publication, in March 1987, of the Catholic Church's condemnation of *in vitro* fertilization, surrogate motherhood, and fetal experimentation, there appeared a cartoon in a Roman newspaper, in which two bishops are standing next to a telescope. In the distant night sky, in addition to Saturn and the Moon, there are dozens of test-tubes. One bishop turns to the other, who is in front of the telescope, and asks: "*This* time what should we do? Should we look or not?" The historical reference to Galileo was clear. In fact, at a press conference at the Vatican, Cardinal Ratzinger was asked whether he thought the Church's response to the new biology would not result in another "Galileo affair." The Cardinal smiled, perhaps realizing the persistent power - at least in the popular imagination - of the story of Galileo's encounter with the Inquisition more than three hundred and fifty years before. The Vatican office which Cardinal Ratzinger now heads, the Congregation for the Doctrine of the Faith, is the direct successor to the Holy Roman and Universal Inquisition.

[2] The legend of Galileo's encounter with the Inquisition is a powerful and persistent feature of the modern world's understanding of what it means to be modern. Galileo has come to represent modern science's fighting to free itself from the clutches of blind faith, biblical literalism, and superstition. The legend of Galileo the scientist sees him as breaking with the scientific views of Aristotle and thereby laying the foundations of modern science. This essay will look again at the story of Galileo, leaving behind, as far as possible, the generally accepted legend both of Galileo's break with Aristotle and of his conflict with the Inquisition. In fact, I will argue that, contrary to the legend, Galileo and the officials of the Inquisition shared common first principles about the nature of scientific truth and the complementarity between science and religion.

[3] Since my topic concerns both science and theology, there is no better place to begin than from what Galileo added in the front of his own copy of the *Dialogue Concerning the Two Chief*

[1] This text is based on a lecture given at Creighton University on 3 February 1999.

World Systems. This book, published in 1632, in which Galileo defended Copernican astronomy, was the immediate cause of his trial before the Inquisition.

> Take care, theologians, that in wishing to make matters of faith of the propositions attendant on the motion and stillness of the Sun and the Earth, in time you probably risk the danger of condemning for heresy those who assert the Earth stands firm and the Sun moves; in time, I say, when sensately or necessarily it will be demonstrated [*quando sensatamente o necessariamente si fusse dimostrato*] that the Earth moves and the Sun stands still (554).

[4] Here we find both Galileo's commitment to demonstrations in science - a commitment which he shares with Aristotle[2] - and his admission that there is not yet such a demonstration for the motion of the Earth. The passage also reaffirms a key principle Galileo set forth in his famous "Letter to the Grand Duchess Christina": that when investigating physical questions one should not begin with biblical texts. Galileo warns the theologians to avoid acting imprudently, lest they be faced with the unpleasant task of condemning as heretical those propositions which they now declare to be orthodox.

Galileo in Historical Context

[5] Let me begin by noting briefly something about Galileo's life and times. Galileo was born in Pisa in 1564, the same year in which Michelangelo died and Shakespeare was born. It was twenty-one years after the publication of Copernicus' treatise on heliocentric astronomy; and forty-seven years after the appearance of Luther's ninety-five theses and the beginning of the Reformation. In fact, the Protestant Reformation, the Catholic response - especially the Council of Trent, whose final session ended in 1563, the destruction of the religious unity of Europe, and the ensuing wars of religion constitute the world in which Galileo will spend his entire life.

[6] Galileo entered the University of Pisa in 1581 to prepare for a career in medicine, but his interests quickly turned to natural philosophy and mathematics. After teaching at Pisa for a few years, he left in 1592 for the University of Padua. It was at Padua, from 1592 to 1610, that he formulated the basic principles of his physics, especially his understanding of the laws of motion.

[7] In 1609 he began to use the newly discovered telescope to observe the heavens, and in March 1610 he published *The Starry Messenger* in which he reported his discoveries that the Milky Way consists of innumerable stars, that the Moon has mountains, and that Jupiter has four

[2] In a letter written to a professor at Bologna in 1640, Galileo, two years before his own death, reaffirmed his commitment to Aristotelian principles of science: ". . . [A]gainst all reason I am impugned as an impugner of the Peripatetic doctrine, whereas I claim (and surely believe) that I observe more religiously the Peripatetic or should I say Aristotelian teaching than do many who wrongfully put me as averse from good Peripatetic philosophy . . . . I consider . . . that to be truly Peripatetic - that is, an Aristotelian philosopher - consists principally in philosophizing according to Aristotelian teachings, proceeding from those methods and with those true suppositions and principles on which scientific discourse is founded, supposing the kind of general knowledge from which one cannot deviate without the greatest defect. Among these suppositions is everything that Aristotle teaches us in his logic, pertaining to care in avoiding fallacies in discourse, using reason well so as to syllogize properly and deduce from the conceded premisses the necessary conclusion, and all this teaching relating to the form of arguing correctly. As to this part, I believe that I have learned sureness of demonstration from the innumerable advances made by pure mathematicians, never fallacious, for if not never, then at least very rarely, have I fallen into mistakes by argumentation. In this matter, therefore, I am a Peripatetic" (Galileo to Fortunio Liceti, 14 September 1640: *Opere*, 18: 248).

satellites. Subsequently, he discovered the phases of Venus and spots on the surface of the Sun. He named the moons of Jupiter the "Medicean Stars" and was rewarded by Cosimo de' Medici, Grand Duke of Tuscany, with appointment as chief mathematician and philosopher at the Duke's court in Florence. The telescopic discoveries, and arguments derived from them, served Galileo well in his public defense of Copernicus' thesis that the Earth and the other planets revolve about the Sun. Galileo thought that his most important discovery were the moons of Jupiter. Copernican astronomy required two centers of heavenly motion: the moon's revolving around the Earth, and the Earth, the Moon, and the other planets' revolving around the Sun. But a universe with more than one center of motion seemed inconceivable. Since it was now clear that four moons revolved around Jupiter and Jupiter itself moved around another center, an important objection to Copernican astronomy would disappear.

[8] Galileo did not think that his telescopic discoveries provided a proof that the Earth rotated on its axis and revolved about the Sun. He did think that they provided arguments for the plausibility of Copernican astronomy. His discovery of the phases of Venus required only that Venus must revolve about the Sun. And, as we shall see, Galileo knew the difference between plausible arguments and scientific demonstrations.

[9] The public position which Galileo occupied in Florence from 1610 involved him in controversy. As the best-known advocate for Copernican astronomy, he attracted criticism. Philosophers, for example, were concerned with the apparent violation of the principles of Aristotelian physics involved in the notion that the Earth moved or that celestial bodies were in any way like the Earth. Criticism also came from some theologians who were troubled about the relationship between Copernican astronomy and the Bible.

[10] In early 1615, well after the debate had begun, a Carmelite priest in Naples, Paolo Foscarini, published an essay in which he claimed that the Bible could be interpreted in such a way as to be consistent with Copernican astronomy. Foscarini sent his essay to Cardinal Roberto Bellarmino, the learned Jesuit and important officer of the Inquisition in Rome. Bellarmino, already an old man, had spent his professional career refuting the views of Protestant theologians. Late in the 16th century he had been named Professor of Controversial Theology at the new Jesuit university in Rome, and he was skilled in the intricacies of biblical interpretation as well as in challenges to the authority of the Church.

[11] Cardinal Bellarmino's response to Foscarini, a copy of which the Cardinal sent to Galileo, is one of the most important documents for understanding Galileo's encounter with the Inquisition. The Cardinal writes:

> First . . . it appears to me that [you] and Signore Galileo are proceeding prudently by limiting yourselves to speaking hypothetically and not absolutely [*ex suppositione e non assolutamente*], as I have always believed Copernicus did [*come io ho sempre creduto che habbia parlato Copernico*]. For to say that, by assuming [*che supposto*] the Earth moves and the Sun stands still, one saves all the appearances [*si salvano tutte le apparenze*] better than by postulating [*porre*] eccentrics and epicycles is to speak well [benissimo detto]. This has no danger in it, and it suffices for mathematicians. But to wish to affirm that the Sun is really fixed in the center of the heavens [*che realmente il sole stia nel centro del mundo*] and merely turns upon itself without traveling from east to west, and that the Earth . . . revolves very swiftly around the Sun, is a very dangerous thing [*cosa molta pericolosa*], likely not only to irritate all the scholastic theologians and

> philosophers, but also to harm our Holy Faith by rendering Holy Scripture false [*di nuocere alla Santa Fede con rendere false le Sante Scritture*]. . . (Finocchiaro [ed.]: 67).

[12] Notice the distinction Cardinal Bellarmino draws between speaking "hypothetically" and speaking "absolutely." To speak hypothetically, in the sense the Cardinal means, is "to save the appearances," and in astronomy "to save the appearances" is to provide a consistent mathematical description of the observed phenomena. Hence, Bellarmino refers to the eccentrics and epicycles of Ptolemaic astronomy, which are mathematical constructs to describe observed movements in the heavens. To speak "absolutely" would be to specify what the movements in the heavens really are.

[13] Bellarmino is wrong, however, in claiming that Copernicus was only interested in saving the phenomena. Perhaps he is only offering pastoral advice to Galileo and Foscarini, suggesting to them a safe way to advance their arguments.

[14] Cardinal Bellarmino observes that the Church has traditionally understood certain passages in the Bible as affirming that the Sun revolves about a stationary Earth.

> Second . . . the Council [of Trent] prohibits interpreting Scripture contrary to the common agreement [*il commune consenso*] of the Holy Fathers; and if [you] would read not only all their works but also the modern commentaries. . . you will find that all agree in expounding literally [*ad literam*] that the Sun is in the heavens and travels swiftly around the Earth, while the Earth is far from the heavens and remains motionless in the center of the world [*sta nel centro del mondo, immobile*]. Now consider, with your sense of prudence [con la sua prudenza], whether the Church could support [*possa sopportare*] giving Scripture a meaning contrary to the Holy Fathers and to all the Greek and Latin expositors (Finocchiaro [ed.]: 67).[3]

Despite the cardinal's claim that the Church's understanding of the Bible was involved in the dispute, he is willing to examine the arguments for the new astronomy.

> . . . if there were a true demonstration [*ci fusse vera dimostrazione*] that the Sun is in the center of the universe [*nel centro del mondo*]. . . and that the Sun does not circle the Earth but the Earth circles the Sun, then one would have to proceed with great care in explaining the Scriptures that appear contrary [*che paiono contrarie*], and say rather that we do not understand them than that what is demonstrated is false. But I will not believe that there is such a demonstration until it is shown to me [*Ma non crederó che ci sia tal dimostrazione, fin che non mi sia mostrata*]. Nor is it the same to demonstrate that by supposing the Sun to be at the center and the Earth in the heaven one can save the appearances, and to demonstrate that in truth [*che in verità*] the Sun is at the center and the Earth in heaven; for I believe the first demonstration may be available, but I have very grave doubts [*grandissimo dubbio*] about the second, and in the case of doubt one

[3] In the final section of this paragraph of the letter (omitted in the text of this essay), Bellarmino argues: "Nor may one reply that this is a not a matter of faith, because if it is not a matter of faith with regard to the subject matter [*ex parte obiecti*], it is with regard to the one who has spoken [*ex parte dicentis*]. Thus that man would be just as much a heretic who denied that Abraham had two sons and Jacob twelve, as one who denied the virgin birth of Christ, for both are declared by the Holy Ghost through the mouths of the prophets and apostles." Cardinal Bellarmino is referring to the decree of the fourth session of the Council of Trent, which prohibits individuals from interpreting scripture, "in matters of faith and morals," contrary to what the Church teaches or contrary to the unanimous teachings of the Church Fathers.

must not abandon [*non si de(v)e lasciare*] the Holy Scripture as interpreted by the Holy Fathers . . . (Finocchiaro [ed.]: 68).

[15] Note, that Bellarmino again draws a distinction between saving the appearances and demonstrating the truth of a position. Note further that, despite his very grave doubts, he admits the possibility of a demonstration for the motion of the Earth, although he is aware of no such demonstration.[4] In the absence of such a demonstration, prudence, at least, requires that the traditional interpretation of those passages of the Bible which claim that the Earth is motionless, be maintained. If the cardinal were to have thought that it was a matter of faith that the Earth did not move, he could not admit even the possibility of a demonstration that the Earth did move. For then he would have admitted that the truth of faith could be contradicted by the truth of reason.

[16] Galileo shared Cardinal Bellarmino's understanding of the difference between an astronomy which "saves the appearances" and an astronomy which demonstrates what is truly so. In his *Letters on Sunspots*, Galileo described his task as the discovery of the "true constitution of the universe," an understanding which is "unique, true, real, and which cannot be other than it is [*solo, vero, reale, ed impossibile ad esser altramente*] . . ." (*Opere*, 5: 102).

Galileo and Aristotelian Science

[17] Galileo the scientist shares with Aristotle and Aquinas, and with Cardinal Bellarmino, the view that science deals with the truth of things.[5] It is important to remember that the Aristotelian notion of science that was current in the age of Galileo is different from what we generally consider science today. Scientific knowledge for Aristotle is knowledge of what is necessarily so, that is, cannot be otherwise, because it is based on the discovery of the causes that make things be what they are. Such sure, certain knowledge is quite different from the product of

[4] Annibale Fantoli argues that, despite what Bellarmino seems to admit in the third paragraph, the cardinal denies the possibility of reconciling Copernican astronomy with the Bible. Bellarmino, according to Fantoli, really doesn't think there is a possibility of a demonstration for the motion of the Earth. In part, Fantoli's claim rests on the remainder of the third paragraph, which I did not include in the text: "I add that the one who wrote, 'The sun also riseth, and the sun goeth down, and hasteth to his place where he arose,' was Solomon, who not only spoke inspired by God, but was a man above all others wise and learned in the human sciences and in the knowledge of created things; he received all this wisdom from God; therefore *it is not likely* that he was affirming something that was contrary to truth already demonstrated or capable of being demonstrated. Now, suppose you say that Solomon speaks in accordance with appearances, since it seems to us that the sun moves (while the Earth does so), just as to someone who moves away from the seashore on a ship it looks as though the shore is moving, I shall answer that when someone moves away from the shore, although it appears to him that the shore is moving away from him, nevertheless he knows that it is an error and corrects it, seeing clearly that the ship moves and not the shore; but in regard to the sun and the Earth, no wise man has any need to correct the error, since he clearly experiences that the Earth stands still and that the eye is not in error when it judges that the sun moves, as it is also not in error when it judges that the Moon and the stars move. And this is enough for now" (1996: 185; my italics). Fantoli thinks that Bellarmino rejects the possibility of a demonstration "on the basis of a philosophical certainty founded on the evidence of common experience: 'because we clearly experience that the Earth stays still.'" Fantoli: "Bellarmino had in his response clearly denied the ideas put forth by Foscarini and by Galileo himself with respect to the possibility of reconciling Copernicanism with Scripture. It was a denial based, as we have seen, both on theological reasons and on a philosophical consideration of 'good sense.'" Fantoli concludes that Bellarmino leaves open only the possibility of defending Copernican astronomy as a mere mathematical hypothesis (1996: 188).

[5] For an excellent account of the Aristotelian character (a "progressive Aristotelianism") of Galileo's science, see William A. Wallace (1984). See also, Enrico Berti (239-62).

probable or conjectural reasoning: reasoning which lacks certitude because it falls short of identifying true and proper causes. Galileo, despite his disagreements with many 17th century Aristotelians, never departed from Aristotle's ideal of science as sure, certain knowledge. Whether Galileo was arguing about the movement of the Earth or about laws that govern the motion of falling bodies, his goal was to achieve true, scientific demonstrations.[6]

[18] Cardinal Bellarmino embraces the same Aristotelian position: namely, that the natural scientist discovers the truths of nature. Thus, he demands that if Galileo, the scientist, wishes to speak "absolutely," he must provide a demonstration for the motion of the Earth: after all, that is what a good scientist does. Without a demonstration a scientist cannot conclude that, in fact, the Earth moves.

[19] The opposition within scientific circles in the early 17th century to claims that the Earth moved was generally based on the assumption that a geocentric astronomy was an essential part of a larger Aristotelian cosmology: the view, that is, that Aristotelian physics and metaphysics depended in some way on the affirmation that the Earth was immobile at the center of the universe. Thus, if one were to reject such a geocentric astronomy, then, *so it seemed to many*, the whole of Aristotelian science would have to be discarded.[7] As a result of such an understanding, or really, misunderstanding, of the interdependence of astronomy, cosmology, physics, and metaphysics, some thought that the acceptance of a moving Earth would involve a radical philosophical revolution. Hence, we might understand why many of Galileo's contemporaries were so troubled by his support for Copernican astronomy. Furthermore, although we now accept without question that the Earth moves, we need to guard against assuming that it is a simple matter to reach this conclusion and that, therefore, the scientific opponents of Galileo were either simple-minded or stubbornly blind to the truth.

[20] An understanding of the theological dimensions of the encounter between Galileo and the Inquisition requires that we keep in mind this question concerning the scientific knowledge of the motion of the Earth. All sides in the controversy were committed to the Aristotelian ideal of scientific knowledge. Remember, Cardinal Bellarmino told Galileo that if there were a demonstration for the motion of the Earth, then the Bible would have to be interpreted accordingly. The cardinal has simply reaffirmed traditional Catholic teaching that the truths of science and the truths of faith cannot contradict one another. Whether we turn to Augustine in

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[6] For an extended discussion of these claims, see Wallace (1984). "Oversimplifying a vast amount of textual study [on Galileo's use of notes from professors at the Collegio Romano], one can say that Galileo's concept of proof in a mathematical physics involves the making of *suppositiones*, with the result that the characteristic method of formulating a proof in this discipline employs reasoning *ex suppositione*. With regard to these "suppositions," however, both Galileo and the Jesuits [in Rome] recognized that there are two types: some are capable of verification, either by induction from sense experience or by measurement to within a specified degree of accuracy. In all of Galileo's serious scientific writings up to, but not including, the *Dialogo*, he is at pains to identify and verify the suppositions on which his reasoning is based, so as to justify his claims for strict proof, and he continues the same procedure in the *Due nuove scienze* and its supporting documents" (Wallace 1983: 326).

[7] It is not as though the theologians accepted all the conclusions of Aristotelian philosophy. Aristotle's claims concerning the eternity of the world and at least the Averroistic interpretation of Aristotle which denied the immortality of the individual soul were rejected. Bellarmino in his lectures at Louvain rejected Aristotle's view that the heavens were incorruptible. Galileo's defense of Copernican astronomy did represent a threat to established philosophical thinking even though that thinking deviated in some respects from the thought of Aristotle. Here we ought to distinguish between principles of Aristotelian metaphysics and physics and particular conclusions which Aristotle reached.

the 4th century or Aquinas in the 13th, we can discover the common Catholic commitment to the harmony between reason and revelation. Furthermore, both Augustine and Aquinas warned against using the Bible as an encyclopedia of natural science. Galileo liked to quote the remarks of Cardinal Baronius: Scripture teaches you how to go to heaven, not how the heavens go.

The Relationship between Science and Scripture

[21] Galileo addresses the question of the relationship between science and the Bible in his famous "Letter to the Grand Duchess Christina." Galileo is the chief scientist in the employ of the Medici family and Christina of Lorraine is the mother of the reigning Grand Duke. The letter contains Galileo's account of the recent controversy over the claims of Copernican astronomy. He composes it in 1615, after having read Bellarmino's response to Foscarini, and in the midst of the debate concerning the relationship between traditional interpretations of the Bible and the view that the Earth moves. Galileo is increasingly concerned that the Church will condemn the conclusions of Copernicus.[8]

[22] By addressing the letter to the Grand Duchess, rather than to theologians in Rome, Galileo is able to write to an educated lay audience, even though his primary audience are the authorities of the Inquisition in Rome. Galileo is not a theologian, and theologians in Rome might well dismiss a theological treatise addressed to them by Galileo the mathematician and physicist.

[23] Galileo is well-trained in Renaissance techniques of rhetoric and a failure to recognize Galileo's rhetorical techniques has resulted in uncritical reading of the letter (see Moss). For example, many modern history texts accept without question Galileo's own account of the history of the controversy, which he presents in the first few paragraphs of the letter. We must remember when we read his account that, first of all, it is his interpretation of the events, and, second, he has chosen his facts carefully in order to achieve his end: *to persuade* the authorities of the Catholic Church not to act foolishly and condemn Copernican astronomy.

[24] He identifies his enemies as being unable to refute him in science, and as a result, they "try to shield the fallacies of their arguments with the cloak of simulated religiousness and with the authority of Holy Scripture, unintelligently using the latter [the Bible] for the confutation of arguments they neither understand nor have heard" (Finocchiaro [ed.]: 89). The story he tells of Copernicus is also interesting. He misidentifies him as a priest, argues that his investigations were undertaken at the request of the Pope, and, noting that Copernicus' book was dedicated to the Pope, Galileo claims: "Once printed this book was accepted by the Holy Church, and it was

[8] In notes he wrote after reading Bellarmino's letter to Foscarini, Galileo observes: "The motion of the Earth and the stability of the Sun could never be against Faith or Holy Scripture, if this proposition were correctly proved to be physically true by philosophers, astronomers, and mathematicians, with the help of sense experience, accurate observations, and necessary demonstrations. However, in this case, if some passages of Scripture were to sound contrary, we would have to say that this is due to the weakness of our mind, which is unable to grasp the true meaning of Scripture in this particular case. This is the common doctrine, and it is entirely right, since one truth cannot contradict another truth. On the other hand, whoever wants to condemn it judicially must first demonstrate it to be physically false by collecting the reasons against it. . . . If the Earth de facto moves, we cannot change nature and arrange for it not to move. But we can rather easily remove the opposition [*la repugnanza*] of Scripture with the mere admission that we do not grasp its true meaning [*il suo vero senso*]. Therefore the way to be sure not to err is to begin with astronomical and physical investigations, and not with scriptural ones" (*Considerazioni circa l'opinione copernicana*, EN, 5: 364-5; cf. Finocchiaro [ed.]: 80-82).

read and studied all over the world without anyone's ever having the least scruple about its doctrine." Galileo concludes his historical observations with the following remark:

> Finally, now that one is discovering how well founded upon clear observations and necessary demonstrations [*quanto ella sia ben fondata sopra manifeste esperienze e necessarie dimostrazioni*] this doctrine is, some persons come along who, without having seen the book, give its author the reward of so much work by trying to have him declared a heretic; this they do only in order to satisfy their special animosity, groundlessly conceived against someone else [Galileo, himself] who has no greater connection with Copernicus than the endorsement of his doctrine (Finocchiaro [ed.]: 90).

[25] Note what Galileo claims and what he does not claim. His comments, at first glance, suggest that Copernican astronomy has been demonstrated to be true, or perhaps has been shown to be true on the basis of "clear observations" [*manifeste esperienze*], no doubt Galileo's telescopic discoveries. But on closer inspection, we see that all Galileo is claiming is that Copernican astronomy is "well founded upon clear observations and necessary demonstrations." To show that a position is "well founded" is not necessarily to show that it has been demonstrated to be true. Galileo is aware of the importance of necessary demonstrations; he has in mind Bellarmino's distinctions in the cardinal's letter to Foscarini. In fact, throughout the "Letter to the Grand Duchess," Galileo uses the phrase "necessary demonstrations" many times, without once offering such a demonstration for the motion of the Earth. Remember the rhetorical nature of the Letter; Galileo seeks to persuade the officers of the Inquisition not to condemn Copernican astronomy. Galileo knows that theologians in Rome accept the position that the truths of science and the truths of faith cannot contradict one another, and that, if there is a scientific demonstration on a particular subject, it would not be possible for the Bible to be authentically interpreted in a way which contradicts what science demonstrates. Remember, in addition, that both Galileo and the officers of the Inquisition share the same Aristotelian ideal of scientific knowledge; both sides understand what a demonstration is. If Galileo, in fact, had a demonstration for the motion of the Earth, he surely would have presented it, for he knew, or at least he would expect, that a demonstration would prevent the Church's condemnation of Copernican astronomy. We see here another reason for ostensibly addressing the letter to the Grand Duchess, for she would not be expected to follow a complex scientific demonstration; it would be sufficient for her chief scientist simply to suggest that one existed.

[26] Throughout the "Letter to the Grand Duchess," Galileo reaffirms traditional Catholic teaching on the relationship between science and scripture. God is the author of both the book of nature and the book of scripture. Therefore, the truths of nature and scripture cannot contradict one another.

[27] One representative passage is illustrative of the general tenor of Galileo's remarks throughout the letter:

> I think that in disputes about natural phenomena one must begin not with the authority of scriptural passages, but with sensory experience and necessary demonstrations [*dalle sensate esperienze e dalle dimostrazioni necessarie*]. For the Holy Scripture and nature derive equally from the Godhead, the former as the dictation of the Holy Spirit and the latter as the obedient executrix of God's orders; moreover, to accommodate the understanding of the common people it is appropriate for Scripture to say many things that are different in appearance and in regard to the surface meaning of the words [*al*

nudo significato delle parole] from the absolute truth . . . and so it seems that natural phenomena [*effetti naturali*] which are placed before our eyes by sensory experience or proved by necessary demonstrations [*la sensata esperienza . . . o le necessarie dimostrazioni ci concludono*] should not be called into question, let alone condemned, on account of scriptural passages whose words appear to have a different meaning [*che avessero nelle parole diverso sembiante*] (Finocchiaro [ed.]: 93).

Conflict with the Inquisition

[28] We know that, by 1615, Galileo was convinced that he was on the verge of achieving a demonstration for the motion of the Earth, but he needed time. He sought to prevent the Church from condemning as heretical the claim that the Earth moves, when he was about to demonstrate that in fact the Earth does move. Galileo expected that an argument from the phenomenon of the tides would provide the necessary demonstration. He circulated a manuscript on this subject in late 1615 and early 1616,[9] and the argument appears in the final section of his *Dialogue Concerning the Two Chief World Systems*, published in 1632. But, in 1615 and 1616, Galileo did not think that he yet had the requisite demonstration. There is some debate among Galileo scholars as to whether he eventually thought that he was able to demonstrate the motion of the Earth from the fact of the ocean tides; I think that Galileo came reluctantly to the conclusion, by the 1620's, that he did not have such a demonstration, although he found the argument persuasive and included it in the *Dialogue*.

[29] In any event, in 1615 and 1616 neither Galileo nor the Inquisition thought there was a demonstration for the motion of the Earth: Galileo expected, indeed anticipated, one; the Inquisition did not. In the absence of a demonstration for the motion of the Earth, Cardinal Bellarmino had urged prudence: do not challenge the traditionally accepted readings of those biblical passages which have been interpreted as affirming the immobility of the Earth. The cardinal was acutely aware of the Protestant challenges to the Catholic Church's claim to be the sole, legitimate interpreter of God's word. In many ways we see the Inquisition especially concerned with maintaining the authority of the Church against all who seemed to threaten it.

[30] Galileo's principles were shared by his opponents in the Inquisition, although they reached a different conclusion when they examined the particular case of Copernican astronomy. The theological consultants of the Inquisition were asked to evaluate the claims of Copernican astronomy. They issued their report to the cardinals of the Inquisition in February 1616, in which they concluded that the claim that the Sun was immobile and at the center of the universe was:

> . . . foolish and absurd in philosophy, and formally heretical since it explicitly contradicts in many places the sense of Holy Scripture, according to the literal meaning of the words

[9] We have the text of a discourse on the tides, written in Rome (or at least completed in Rome) in January 1616 and addressed to Cardinal Orsini. In this text Galileo writes of the need to discover the "true cause" of the tides, and he suggests: "Let us, then, take the motion of the Earth hypothetically [*ex hypothesi*], in particular those same motions which many ancients and other recent philosophers have attributed to it on account of other sensible effects; and let us consider what consequences and relevance they may have for the present subject [the tides]." Near the end of the discourse, Galileo writes: "This was what I advanced as the cause of these motions of the sea in my discussion with you, Most Eminent Lord. It was an idea which seemed to harmonize mutually the earth's motion and the tides, taking the former as the cause of the latter, and the latter as a sign of and an argument for the former. . . . At the moment I only claim to have given something of a sketch, suitable at least for stimulating students of nature to reflect on this new idea of mine" (Finocchiaro [ed.]: 122, 131, and 133).

> and according to the common interpretation and understanding of the Holy Fathers and the doctors of theology (Finocchiaro [ed.]: 146).

The theologians also concluded that the claim that the Earth moves was also foolish and absurd in philosophy and, "in regard to theological truth it is at least erroneous in faith."

[31] It is important to note that the first part of each of these two conclusions reached by the theologians is that Copernican astronomy is "false and absurd" philosophically [*stultam et absurdum*]. Why should the theological experts of the Inquisition care whether Copernican astronomy is false scientifically? First of all, there is the ancient Catholic commitment to the safeguarding of reason since, as Aquinas would say, reason is a way to God. Aquinas, himself, refers to those propositions about God, such as that He exists, which serve as preambles to faith. More importantly for our purposes, I think, is that the theologians of the Inquisition were committed to the complementarity between science and scripture. If a proposed scientific proposition is false, scripture cannot be in agreement with it, since the Bible cannot affirm as true that which reason knows to be false. Furthermore, in reaching the conclusion that Copernican astronomy contradicts the Bible, the theologians accepted as incontrovertibly true a particular geocentric cosmology, and, on the basis of such an acceptance, they insisted that the Bible be read in a certain way. Thus, in part, they subordinated scriptural interpretation to a physical theory. They proceeded in this manner because, like Galileo, they were convinced that the Bible contained scientific truths and that, on the basis of what is known to be true in the natural sciences, one could discover the same truth in related biblical passages. They do not argue - as most commentators mistakenly think - that the proposition is false scientifically *because* it contradicts the Bible. In fact, their argument is just the opposite![10]

[32] Not persuaded by Galileo's arguments, the Inquisition in 1616 ordered Galileo not to hold, teach, or defend the condemned propositions, and the text of Copernicus must no longer be published until it is corrected. The corrections eventually ordered by the Index of Forbidden Books involve changing those passages in which Copernicus claims that in fact the Earth moves to read that he simply supposes or hypothesizes that the Earth moves. The order for the correction of Copernicus' text is instructive: "If certain of Copernicus' passages on the motion of the Earth are not hypothetical, make them hypothetical; then they will not be against either the truth or the holy writ. On the contrary, in a certain sense, they will be in agreement with them, on account of the false nature of suppositions, which the study of astronomy is accustomed to use as its special right."[11] The distinction between speaking hypothetically and speaking absolutely, which Bellarmino had urged upon Galileo in April 1615, as prudential advice, now serves as the basis for the disciplinary decrees of the Inquisition and the Index of Forbidden Books.

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[10] Many transcriptions of the report of the theological consultants fail to place a comma after the word "philosophia." The original Vatican manuscript (folio 42r) has a semicolon after "philosophia" and the late nineteenth century edition of the collected works of Galileo (19: 321) has a comma. Most translations into English omit the punctuation. Such a transcription, without a comma, "conveys the impression" that contradicting the Bible "is being given as a reason for ascribing both philosophical-scientific and theological heresy." But the comma between "philosophia" and "et" separates the claim of theological heresy from the claim of philosophical and scientific error. The distinction is crucial! For the original manuscript shows us that the theologians first conclude that the proposition is false and absurd philosophically *and then* conclude that it is heretical because it contradicts the Bible (see Finocchiaro [ed.]: 344, note 35).

[11] "Codex Barberiniano XXXIX.55," transcribed by Joseph Hilgers, *Der Index der Verbotener Bucher* (Freiburg, 1904), 541.

[33] As I have indicated, the theologians of the Inquisition, committed as they were to the complementarity between science and scripture, accepted as obviously true a particular geocentric cosmology, and, on the basis of such a commitment, insisted that the Bible must be read in a certain way. Furthermore, just as some philosophers mistakenly concluded that Aristotelian physics and metaphysics depended on a geocentric cosmology, so some theologians feared that a rejection of Aristotle's view that the Earth does not move would call into question all of Aristotelian philosophy, a philosophy upon which important elements of Catholic theology depended. Catholic theologians, for example, had long employed Aristotelian physics and metaphysics in their exposition of the doctrine of transubstantiation.[12]

[34] The theologians of the Inquisition thought that the Bible contained scientific truths. Since it was obvious, from science, that the Earth does not move, and since certain passages in the Bible seemed clearly to say or to imply the same thing, it must be the case that the Bible proclaims that the Earth does not move. Furthermore, in the face of the Protestant Reformation, the Catholic Church was particularly alert to threats, real or imagined, to traditional interpretations of the Bible and to the authority of the Church to determine the true meaning of the Bible.

[35] The famous trial of Galileo in 1633, after the publication of his *Dialogue Concerning the Two Chief World System*, depends on the decisions reached seventeen years earlier. The theological, philosophical, and scientific questions which constitute the heart of the controversy are clear by 1616. The Inquisition expected Galileo to obey their orders not to hold, teach, or defend Copernican astronomy. The cardinals who sat in judgment of Galileo in 1633 were convinced that he had violated that injunction and they demanded that he formally renounce the views proscribed seventeen years before. In the formal sentence of June 1633, the Inquisition noted that the *Dialogue* explicitly violated the 1616 injunction since Galileo, in this book, "defended the said opinion [of the Earth's motion and the Sun's stability] already condemned and so declared to your face, although in the said book you try by means of various subterfuges to give the impression of leaving it undecided and labeled as probable; this is still a very serious error [*errore gravissimo*] since there is no way an opinion declared and defined contrary to divine Scripture may be probable [*non potendo in niun modo esser probabile un'opinione dichiarata e difinita per contraria alla Scrittura divina*]" (Finocchiaro [ed.]: 289).[13] Thus, as I have argued, the key to the controversy between Galileo and the Inquisition is an examination of the events of 1615 and 1616, rather than the famous trial of 1633.[14]

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[12] Thomas Campanella notes, in 1622: "The first argument against Galileo is that it seems that theological doctrines would be completely overthrown by anyone who tries to introduce new ideas which are contrary to the physics and metaphysics of Aristotle, on which St. Thomas and all the Scholastics based their theological writings" (43).

[13] Note the argument that one cannot say that an opinion is probable if it has been declared and defined to be contrary to the Bible. It is important to remember the distinction between possible and probable. Probable means that the preponderance of evidence favors a view. Obviously, a Catholic must use the evidence of what Scripture says in determining whether a position is probable. For the officers of the Inquisition, to defend the opinion that the Earth moves and the Sun stands still as "probable" would mean that one had ignored or seriously undervalued the clear evidence of the Bible. The certificate Galileo had from Cardinal Bellarmino (May 1616) which attested only to the fact that Galileo had been told that this opinion was contrary to Scripture only aggravated Galileo's case further, according to the sentence of 1633, since it shows that Galileo knew that it was contrary to Scripture yet "dared to treat of it, defend it, and show it as probable" (Finocchiaro [ed.]: 290).

[14] During the pontificate of Pope Urban VIII, which began in 1623, a new argument entered the arena of discourse concerning Copernican astronomy. This is the view that God's omnipotence renders impossible any claims to sure and certain knowledge of the world of nature. This is a complex question which requires extensive analysis, and

[36] How then do we understand the "Galileo Affair"? Despite the powerful legend of the warfare between science and theology, we need to recognize that the errors in judgment committed by the theologians of the Inquisition involved the subordination of the interpretation of certain biblical passages to a particular cosmology, and that these errors resulted in disciplinary abuses, not doctrinal falsehoods. Without a demonstration for the motion of the Earth, it was indeed possible to believe that the Bible affirmed that the Earth did not move.[15] To insist upon such an affirmation, however, is to violate principles established by Augustine and Aquinas. Nevertheless, the controversy between Galileo and the Inquisition is inconceivable were it not the case that both sides shared common principles: the complementarity between faith and reason, the Bible and science; the role of the Church as the authentic interpreter of scripture; and a commitment to an Aristotelian ideal of demonstration in science In an ironic sense, we might say that the "Galileo Affair" offers ample testimony, not for the warfare between science and theology, but for the harmony between the two.

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there is no room in this essay for such analysis. Enrico Berti writes that it is clear that "il motivo della condanna del *Dialogo* fu il suo modo di argomentare, in particolare a proposito delle maree, il quale fu interpretato come implicante un nesso di necessità tra Dio e il mondo e come tale fu giudicato incompatibile con la fede nell'onnipotenza, cioè nella trascendenza divina" (256).

[15] This is the argument set forth by William Wallace: "Both before and after the publication of the *Dialogo*, therefore, Galileo gives abundant evidence of his awareness of the canons of demonstrative proof, and how to use these to achieve true science. In the *Dialogo* itself, the character of the discourse shifts away from demonstration and substitutes persuasive argumentation instead. The earth's diurnal rotation, it is admitted, is never proved. Galileo only advances the claim that it is not *disproved* by the Ptolemaic arguments. Similarly he provides no conclusive evidence for the earth's annual revolution around the sun - simply arguments from analogy . . . Finally came the argument from the tides, which Galileo refers to in the preface as his *fantasia ingegnosa*, and over which he worked for years in an attempt to remove its flaws, without notable success" (1983: 328). Maurice Finocchiaro, in *Galileo and the Art of Reasoning*, offers an extensive analysis of the rhetorical nature of the entire *Dialogo*.

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