

Galileo affair

The Galileo affair was a sequence of events, beginning around 1610, during which Galileo Galilei came into conflict with the Aristotelian scientific view of the universe (supported by the Catholic Church), over his support of Copernican astronomy.[1]

In 1610, Galileo published his *Sidereus Nuncius* (Starry Messenger), describing the surprising observations that he had made with the new telescope. These and other discoveries[vague] exposed severe difficulties with the scientific understanding of the universe that had existed since the beginning of science, and raised interest in new ideas such as the heliocentric theory of Copernicus (published in *De revolutionibus orbium coelestium* in 1543).

Many scientists attacked the theory because it disagreed with Aristotle's model of the universe, as well as several passages of Scripture. Notable among these was Tycho Brahe, one of the most prominent astronomers of his day, who had pointed out what he saw as problems of physics and astronomy in the theory of Copernicus, as well as problems of religion. Galileo's part in the controversies over theology, astronomy, and philosophy culminated in his trial and sentencing by the Roman Inquisition in 1633 on a grave suspicion of heresy.

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[edit] 1600 revolution in cosmology

Galileo began his telescopic observations in the later part of 1609, and by March 1610 was able to publish a small book, *The Starry Messenger* (*Sidereus Nuncius*), relating some discoveries that had not been dreamed of in the philosophy of the time: mountains on the Moon, lesser moons in orbit around Jupiter, and the resolution of what had been thought cloudy masses in the sky (*nebulae*) into collections of stars too faint to see individually without a telescope. Other observations followed, including the phases of Venus and the existence of sunspots.

None of these findings, which were difficult at first for other astronomers to verify, proved that the Earth moved, or directly contradicted either Aristotle's model or Christian doctrine. However, they caused difficulties for natural philosophers of the time, as they contradicted scientific and philosophical ideas based on those of Aristotle and Ptolemy and closely associated with the Catholic Church then (despite their being pagan authors). In particular, the phases of Venus, which showed it to circle the sun, and the observation of moons orbiting Jupiter contradicted the geocentric model of Ptolemy, in which the motion of all celestial bodies was centered on the Earth.

Jesuit astronomers, experts both in Church teachings, science, and in natural philosophy, were at first skeptical and hostile to the new ideas; however, within a year or two the availability of good telescopes enabled them to repeat the observations. In 1611, Galileo visited the Collegium Romanum in Rome, where the Jesuit astronomers by that time had repeated his observations. Christoph Grienberger, one of the Jesuit scholars on the faculty, sympathized with Galileo's theories, but was asked to defend the Aristotelian viewpoint by Claudio Acquaviva, the Father General of the Jesuits. Not all of Galileo's claims were completely accepted: Christopher Clavius, the most distinguished astronomer of his age, never was reconciled to the idea of mountains on the Moon, and outside the collegium many still disputed the reality of the observations. In a letter to Kepler of August 1610,[2] Galileo complained that some of the philosophers who opposed his discoveries had refused even to look through a telescope:[3]

My dear Kepler, I wish that we might laugh at the remarkable stupidity of the common herd. What do you have to say about the principal philosophers of this academy who are filled with the stubbornness of an asp and do not want to look at either the planets, the moon or the telescope, even though I have freely and deliberately offered them the opportunity a thousand times? Truly, just as the asp stops its ears, so do these philosophers shut their eyes to the light of truth."[4]

Geocentrists who did verify and accept Galileo's findings had an alternative to Ptolemy's model in an alternative geocentric (or "geo-heliocentric") model proposed some decades earlier by Tycho Brahe—a model, in which, for example, Venus circled the sun.

Galileo became involved in a dispute over priority in the discovery of sunspots with Christoph Scheiner, a prominent Jesuit. This became a bitter lifelong feud. Neither of them, however, was the first to recognise sunspots—the Chinese had already been familiar with them for centuries.[5]

At this time, Galileo also engaged in a dispute over the reasons that objects float or sink in water, siding with Archimedes against Aristotle. The debate was unfriendly, and Galileo's blunt and sometimes sarcastic style, though not extraordinary in academic debates of the time, made him enemies. During this controversy one of Galileo's friends, the painter, Lodovico Cardi da Cigoli, informed him that a group of malicious opponents, which Cigoli subsequently referred to derisively as "the Pigeon league,"[6] was plotting to cause him trouble over the motion of the earth, or anything else that would serve the purpose.[7] According to Cigoli, one of the plotters had asked a priest to denounce Galileo's views from the pulpit, but the latter had refused. Nevertheless, three years later another priest, Tommaso Caccini, did in fact do precisely that, as described below.

[edit] Bible argument

From antiquity, the majority of educated people subscribed to the Aristotelian view of geocentrism that the earth was the center of the universe and that all heavenly bodies revolved around the Earth. Despite the use of Copernican theories to reform the calendar in 1582,[8] this agreed with a literalist

interpretation of Scripture in several places, such as 1 Chronicles 16:30, Psalm 93:1, Psalm 96:10, Psalm 104:5, Ecclesiastes 1:5. Further, since it was believed that in the incarnation the Son of God had descended to the earth and become man, it seemed fitting that the Earth be the center around which all other celestial bodies moved. Heliocentrism, the theory that the Earth was a planet, which, along with all the others, revolved around the Sun, contradicted both geocentrism and the prevailing theological support of the theory.

One of the first suggestions of heresy that Galileo had to deal with came in 1613 from a professor of philosophy (what we would now call a professor of scientific theory), Cosimo Boscaglia, who was neither a theologian nor a priest. In conversation with Galileo's patron, Cosimo II de' Medici, Boscaglia gave the opinion that the telescopic discoveries were valid, but the motion of the Earth was obviously contrary to Scripture. Galileo was defended on the spot by a Benedictine abbot, Benedetto Castelli, who was also a professor of mathematics and a former student of Galileo's. This exchange, reported to Galileo by Castelli, led Galileo to write a letter to Castelli,[9] expounding his views on what he considered the most appropriate way of treating scriptural passages which made assertions about natural phenomena.[10] Later, in 1615, he expanded this into his much longer Letter to the Grand Duchess Christina.[11]

Tommaso Caccini, a Dominican friar, appears to have made the first dangerous attack on Galileo. Preaching a sermon in Florence at the end of 1614, he denounced Galileo, his associates, and mathematicians in general (a category that included astronomers). The biblical text for the sermon on that day was Joshua 10, in which Joshua makes the Sun stand still; this was the story that Castelli had had to interpret for the Medici family the year before. It is said, though it is not verifiable, that Caccini also used the passage "Ye men of Galilee, why stand ye gazing up into heaven?"[12]

[edit] First meetings with theological authorities

Galileo argued that his telescopic observations favored the Copernican heliocentric theory as a physical truth.[13][not in citation given]

In late 1614 or early 1615, one of Caccini's fellow Dominicans, Niccolò Lorini, acquired a copy of Galileo's letter to Castelli, which he considered of sufficiently doubtful orthodoxy to bring to the attention of the Inquisition. In February 1615 he accordingly sent a copy to the Secretary of the Inquisition, Cardinal Paolo Emilio Sfondrati, with a covering letter critical of Galileo's supporters.[14]

On March 19, Caccini arrived at the Inquisition's offices in Rome to denounce Galileo for his Copernicanism and various other alleged heresies supposedly being spread by his pupils.[15]

Galileo soon heard reports that Lorini had obtained a copy of his letter to Castelli and was claiming that it contained many heresies. He also heard that Caccini had gone to Rome and suspected him of trying to stir up trouble with Lorini's copy of the letter.[16] As 1615 wore on he became more concerned, and eventually determined to go to Rome as soon as his health permitted, which it did at the end of the year. By presenting his case there, he hoped to clear his name of any suspicion of heresy, and to persuade the Church authorities not to suppress heliocentric ideas. In this he was acting against the advice of friends and allies, and the Tuscan ambassador to Rome, Piero Guicciardini.

[edit] Bellarmine's view

Robert Cardinal Bellarmine, one of the most respected Catholic theologians of the time, was called on

to adjudicate the dispute between Galileo and his opponents, including both religious and secular university professors.[citation needed] The question of heliocentrism had first been raised with Cardinal Bellarmine, in the case of Paolo Antonio Foscarini, a Carmelite father; Foscarini had published a book, *Lettera ... sopra l'opinione ... del Copernico*, which attempted to reconcile Copernicus with the biblical passages that seemed to be in contradiction. Bellarmine at first expressed the opinion that Copernicus's book would not be banned, but would at most require some editing so as to present the theory purely as a calculating device for "saving the appearances."[17]

Foscarini sent a copy of his book to Bellarmine, who replied in a letter of April 12, 1615.[18] Galileo is mentioned by name in the letter, and a copy was soon sent to him. After some preliminary salutations and acknowledgements, Bellarmine begins by telling Foscarini that it is prudent for him and Galileo to limit themselves to treating heliocentrism as a merely hypothetical phenomenon and not a physically real one. Further on he says that interpreting heliocentrism as physically real would be "a very dangerous thing, likely not only to irritate all scholastic philosophers and theologians, but also to harm the Holy Faith by rendering Holy Scripture as false." Moreover, while the topic was not inherently a matter of faith, the statements about it in Scripture were so by virtue of who said them—namely, the Holy Spirit. He conceded that if there were conclusive proof, "then one would have to proceed with great care in explaining the Scriptures that appear contrary; and say rather that we do not understand them, than that what is demonstrated is false." However, demonstrating that heliocentrism merely "saved the appearances" could not be regarded as sufficient to establish that it was physically real. Although he believed that the former may well have been possible, he had "very great doubts" that the latter would be, and in case of doubt it was not permissible to depart from the traditional interpretation of Scriptures. His final argument was a rebuttal of an analogy that Foscarini had made between a moving Earth and a ship on which the passengers perceive themselves as apparently stationary and the receding shore as apparently moving. Bellarmine replied that in the case of the ship the passengers know that their perceptions are erroneous and can mentally correct them, whereas the scientist on the Earth clearly experiences that it is stationary and therefore the perception that the Sun, moon and stars are moving are not in error and have no need to be corrected.

Bellarmino found no problem with heliocentrism so long as it was treated as a purely hypothetical calculating device and not as a physically real phenomenon, but he did not regard it as permissible to advocate the latter unless it could be conclusively proved through current scientific standards. This put Galileo in a difficult position, because he believed that the available evidence strongly favoured heliocentrism, and he wished to be able to publish his arguments, but he did not have the conclusive proof necessary to satisfy Bellarmine's requirements.[19]

[edit] Inquisition examination

On February 19, 1616, the Inquisition asked a commission of theologians, known as qualifiers, about the propositions of the heliocentric view of the universe.[20] Historians of the Galileo affair have offered different accounts of why the matter was referred to the qualifiers at this time. Beretta points out that the Inquisition had taken a deposition from Gianozzi Attavanti in November, 1615,[21] as part of its investigation into the denunciations of Galileo by Lorini and Caccini. In this deposition, Attavanti confirmed that Galileo had advocated the Copernican doctrines of a stationary Sun and a mobile Earth, and as a consequence the Tribunal of the Inquisition would have eventually needed to determine the theological status of those doctrines. It is however possible, as surmised by the Tuscan ambassador, Piero Guiccardini, in a letter to the Grand Duke,[22] that the actual referral may have been precipitated by Galileo's aggressive campaign to prevent the condemnation of Copernicanism.[23]

On February 24 the Qualifiers delivered their unanimous report: the idea that the Sun is stationary is "foolish and absurd in philosophy, and formally heretical since it explicitly contradicts in many places the sense of Holy Scripture..."; while the Earth's movement "receives the same judgement in philosophy and ... in regard to theological truth it is at least erroneous in faith."

At a meeting of the cardinals of the Inquisition on the following day, Pope Paul V instructed Bellarmine to deliver this result to Galileo, and to order him to abandon the Copernican opinions; should Galileo resist the decree, stronger action would be taken. On February 26, Galileo was called to Bellarmine's residence, and accepted the orders.[24] On March 5, the decree was issued by the Congregation of the Index, prohibiting, condemning, or suspending various books which advocated the truth of the Copernican system.

Galileo met again with Bellarmine, apparently on friendly terms; and on March 11 he met with the Pope, who assured him that he was safe from persecution so long as he, the Pope, should live. Nonetheless, Galileo's friends Sagredo and Castelli reported that there were rumors that Galileo had been forced to recant and do penance. To protect his good name, Galileo requested a letter from Bellarmine stating the truth of the matter. This letter assumed great importance in 1633, as did the question whether Galileo had been ordered not to "hold or defend" Copernican ideas (which would have allowed their hypothetical treatment) or not to teach them in any way. If the Inquisition had issued the order not to teach heliocentrism at all, it would have been ignoring Bellarmine's position.

In the end, the mission was a failure. Galileo did not persuade the Church to stay out of the controversy, but instead saw heliocentrism formally declared an idea that could not be held as truth, for lack of evidence. It was consequently termed heretical by the Qualifiers, since it contradicted the literal meaning of the Scriptures, though this position was not binding on the Church. Foscarini's book was banned; while Copernicus' *De Revolutionibus*, though not formally banned, was removed from circulation pending revisions, and in fact was not fully cleared until the 19th century. Though Galileo was personally safe, and his works had not been banned, there was now much doubt (felt by other astronomers as far away as Germany) whether it was possible to do serious work in Copernican astronomy.[citation needed]

[edit] Dialogue

In 1623, Pope Gregory XV, died, and was succeeded by Pope Urban VIII, who showed greater favor to Galileo, particularly after Galileo traveled to Rome to congratulate the new Pontiff.[25]

Dava Sobel[26] explains that during this time, Urban had begun to fall more and more under the influence of court intrigue and problems of state. His friendship with Galileo began to take second place to his feelings of persecution and fear for his own life. At this low point in Urban's life, the problem of Galileo was presented to the pope by court insiders and enemies of Galileo. Coming on top of the recent claim by the then Spanish cardinal that Urban was soft on defending the church, he reacted out of anger and fear. This situation did not bode well for Galileo's defense of his book.

In his 1998 book, *Scientific Blunders*, Robert Youngson indicates that Galileo struggled for two years against the ecclesiastical censor to publish a book promoting heliocentrism. He claims the book passed only as a result of possible idleness or carelessness on the part of the censor, who was eventually dismissed. On the other hand, Jerome K. Langford and Raymond J. Seeger contend that Pope Urban and the Inquisition gave formal permission to publish the book, *Dialogue Concerning the Two Chief World Systems*, Ptolemaic & Copernican. They claim Urban personally asked Galileo to give

arguments for and against heliocentrism in the book, to include Urban's own arguments, and for Galileo not to advocate heliocentrism.

The Dialogue, which was published in 1632 to great popularity, was an account of conversations between a Copernican scientist, Salviati, an impartial and witty scholar named Sagredo, and a ponderous Aristotelian named Simplicio, who employed stock arguments in support of geocentricity, and was depicted in the book as being an intellectually inept fool. Simplicio's arguments are systematically refuted and ridiculed by the other two characters with what Youngson calls "unassailable proof" for the Copernican theory (at least versus the theory of Ptolemy—as Finocchiaro points out, "the Copernican and Tychonic systems were observationally equivalent and the available evidence could be explained equally well by either"[27]), which reduces Simplicio to baffled rage, and makes the author's position unambiguous.[25] Indeed, although Galileo states in the preface of his book that the character is named after a famous Aristotelian philosopher (Simplicius in Latin, Simplicio in Italian), the name "Simplicio" in Italian also has the connotation of "simpleton." [28] Although authors Langford and Stillman Drake assert that Simplicio was modeled on philosophers Lodovico delle Colombe and Cesare Cremonini, Pope Urban's demand for his own arguments to be included in the book resulted in Galileo putting them in the mouth of Simplicio. It is not clear why Galileo chose to do this rather than create another character to represent Pope Urban's views. In any event, Galileo had mocked the very person he needed as a benefactor. He also alienated his long-time supporters, the Jesuits, with attacks on one of their astronomers. This portrayal of Simplicio made Dialogue appear as an advocacy book: an attack on Aristotelian geocentrism and defence of the Copernican theory, and because Galileo gave Urban's words to Simplicio to espouse, furious cardinals insisted to Pope Urban that Simplicio was intended to represent him. Though this was not the case, as Galileo was a friend of Urban's who was grateful for Urban's support to date, Urban was persuaded of this notion, and months after the book's publication, banned its sale and had its text submitted for examination by a special commission, which reported against Galileo.[25] Most historians agree Galileo did not act out of malice and felt blindsided by the reaction to his book.[29]

[edit] Redondi's theory

According to a controversial alternative theory, proposed by Pietro Redondi in 1983,[30] the main reason for Galileo's condemnation in 1633 was his attack on the Aristotelian doctrine of matter rather than his defence of Copernicanism. An anonymous document discovered by Redondi in the Vatican archives had argued that the atomism espoused by Galileo in his previous work, *The Assayer*, of 1623 was incompatible with the doctrine of transubstantiation of the Eucharist.[31] At the time, investigation of this complaint was apparently trusted to a Father Giovanni di Guevara, who was well-disposed towards Galileo, and who cleared *The Assayer* from any taint of unorthodoxy.[32] However, according to Redondi:

The Jesuits, who had been deeply offended by *The Assayer*, regarded the ideas about matter expressed by Galileo in *The Dialogue* as further evidence that his atomism was heretically inconsistent with the doctrine of the Eucharist, and strongly protested against it on these grounds.[33]

Pope Urban VIII, who had been under attack by Spanish cardinals for being too tolerant of heretics, but who had also encouraged Galileo to publish *The Dialogue*, would have been severely compromised if his enemies among the Cardinal Inquisitors had found out that he had been guilty of supporting a publication containing Eucharistic heresies.

Urban, after banning the book's sale, established a commission to examine *The Dialogue*,[25] ostensibly for the purpose of determining whether it would be possible to avoid referring the matter to the Inquisition at all, and as a special favor to Galileo's patron, the Grand Duke of Tuscany. Urban's real purpose, though, was to avoid having the accusations of Eucharistic heresy referred to the Inquisition,

and he stacked the commission with friendly commissioners who could be relied upon not to mention them in their report.[citation needed] The commission reported against Galileo.[25]

Redondi's theory has been severely criticized, and almost universally rejected, by other Galileo scholars.[34] However, it has been supported recently by science writer Michael White.[35]

[edit] Trial

Cristiano Banti's 1857 painting Galileo facing the Roman Inquisition

With the loss of many of his defenders in Rome because of *Dialogue Concerning the Two Chief World Systems*, Galileo was ordered to stand trial on suspicion of heresy in 1633, "for holding as true the false doctrine taught by some that the sun is the center of the world", against the 1616 condemnation, since "it was decided at the Holy Congregation [...] on 25 Feb 1616 that [...] the Holy Office would give you an injunction to abandon this doctrine, not to teach it to others, not to defend it, and not to treat of it; and that if you did not acquiesce in this injunction, you should be imprisoned".[36] A panel of theologians, consisting of Melchior Inchofer, Agostino Oreggi and Zaccaria Pasqualigo, reported on the *Dialogue*. Their opinions were strongly argued in favour of the view that the *Dialogue* taught the Copernican theory.[37]

Galileo was found guilty, and the sentence of the Inquisition, issued on 22 June 1633,[38] was in three essential parts:

Galileo was found "vehemently suspect of heresy," namely of having held the opinions that the Sun lies motionless at the center of the universe, that the Earth is not at its centre and moves, and that one may hold and defend an opinion as probable after it has been declared contrary to Holy Scripture. He was required to "abjure, curse, and detest" those opinions.[39]

He was sentenced to formal imprisonment at the pleasure of the Inquisition.[40] On the following day this was commuted to house arrest, which he remained under for the rest of his life.

His offending *Dialogue* was banned; and in an action not announced at the trial, publication of any of his works was forbidden, including any he might write in the future.[41]

According to popular legend, after his abjuration Galileo allegedly muttered the rebellious phrase *And yet it moves*, but there is no evidence that he actually said this or anything similar. The first account of the legend dates to a century after his death.[42]

After a period with the friendly Archbishop Piccolomini in Siena, Galileo was allowed to return to his villa at Arcetri near Florence, where he spent the remainder of his life under house arrest. He continued his work on mechanics, and in 1638, he published a scientific book in Holland. His standing would remain questioned at every turn. In March 1641, Vincentio Reinieri, a follower and pupil of Galileo, wrote him at Arcetri that an Inquisitor had recently compelled the author of a book printed at Florence to change the words "most distinguished Galileo" to "Galileo, man of noted name." [43]

However, partially in tribute to Galileo, at Arcetri the first academy devoted to the new experimental science, The *Accademia del Cimento* was formed, which is where Francesco Redi performed the first controlled experiment and many other important advancements were made which would eventually help usher in The Age of Enlightenment.

[edit] Modern Catholic Church views

In 1758 the Catholic Church dropped the general prohibition of books advocating heliocentrism from the Index of Forbidden Books.[44] It did not, however, explicitly rescind the decisions issued by the Inquisition in its judgement of 1633 against Galileo, or lift the prohibition of uncensored versions of Copernicus's *De Revolutionibus* or Galileo's *Dialogue*.^[44] As a result, the precise doctrinal status of heliocentrism remained unclear, and many Catholic scientists continued to pay lip service to the view that it could only be treated as a hypothesis.^[44] Others, however, openly endorsed it as an established fact without meeting any official opposition from the Church.^[45] The issue finally came to a head in 1820 when the Master of the Sacred Palace (the Church's chief censor), Filippo Anfossi, refused to license a book by a Catholic canon, Giuseppe Settele, because it openly treated heliocentrism as a physical fact.^[46] Settele appealed to the then pope, Pius VII. After the matter had been reconsidered by the Congregation of the Index and the Holy Office, Anfossi's decision was overturned.^[46] Copernicus's *De Revolutionibus* and Galileo's *Dialogue* were then subsequently omitted from the next edition of the Index when it appeared in 1835.

On February 15, 1990, in a speech delivered at La Sapienza University in Rome,^[47] Cardinal Ratzinger, now Pope Benedict XVI, cited some current views on the Galileo affair as forming what he called "a symptomatic case that illustrates the extent to which modernity's doubts about itself have grown today in science and technology."^[48] As evidence, he presented the views of a few prominent philosophers including Ernst Bloch and Carl Friedrich von Weizsäcker, as well as Paul Feyerabend, whom he quoted as saying:

The Church at the time of Galileo kept much more closely to reason than did Galileo himself, and she took into consideration the ethical and social consequences of Galileo's teaching too. Her verdict against Galileo was rational and just, and the revision of this verdict can be justified only on the grounds of what is politically opportune.^[49]

Ratzinger did not indicate whether he agreed or disagreed with Feyerabend's assertions, but he did say "It would be foolish to construct an impulsive apologetic on the basis of such views."^[48]

In 1992, it was reported in the news that the Catholic Church had turned around towards vindicating Galileo^[50]:

Thanks to his intuition as a brilliant physicist and by relying on different arguments, Galileo, who practically invented the experimental method, understood why only the sun could function as the centre of the world, as it was then known, that is to say, as a planetary system. The error of the theologians of the time, when they maintained the centrality of the Earth, was to think that our understanding of the physical world's structure was, in some way, imposed by the literal sense of Sacred Scripture....

—Pope John Paul II, *L'Osservatore Romano* N. 44 (1264) - November 4, 1992

In 2000, Pope John Paul II issued a formal apology for all the mistakes committed by some Catholics in the last 2,000 years of the Catholic Church's history, including the trial of Galileo among others.^[51]
^[52]

In January 2008, as Pope Benedict XVI, Ratzinger canceled a visit to La Sapienza University, the same one he had visited in 1990, following a protest letter signed by 67 of its 4,500 academics, as well as a few dozen of its 135,000[citation needed] students. The petition included a truncated version of the Feyerabend quotation and asserted that Ratzinger's reiteration of the quoted words had "offended and humiliated" them.[53][54] The full text of the speech that would have been given was made available a few days following Pope Benedict's cancelled appearance at the university.[55] La Sapienza's rector, Renato Guarini, has been quoted as stating that the cancellation was a "defeat for the freedom of expression"; Italian Prime Minister Romano Prodi echoed such concerns.[56] Also notable were public counter-statements by La Sapienza professors Giorgio Israel[57] and Bruno Dalla Piccola.[53]

[edit] Artistic treatments

The Galileo affair forms the subject of the play *Life of Galileo* by Bertolt Brecht.