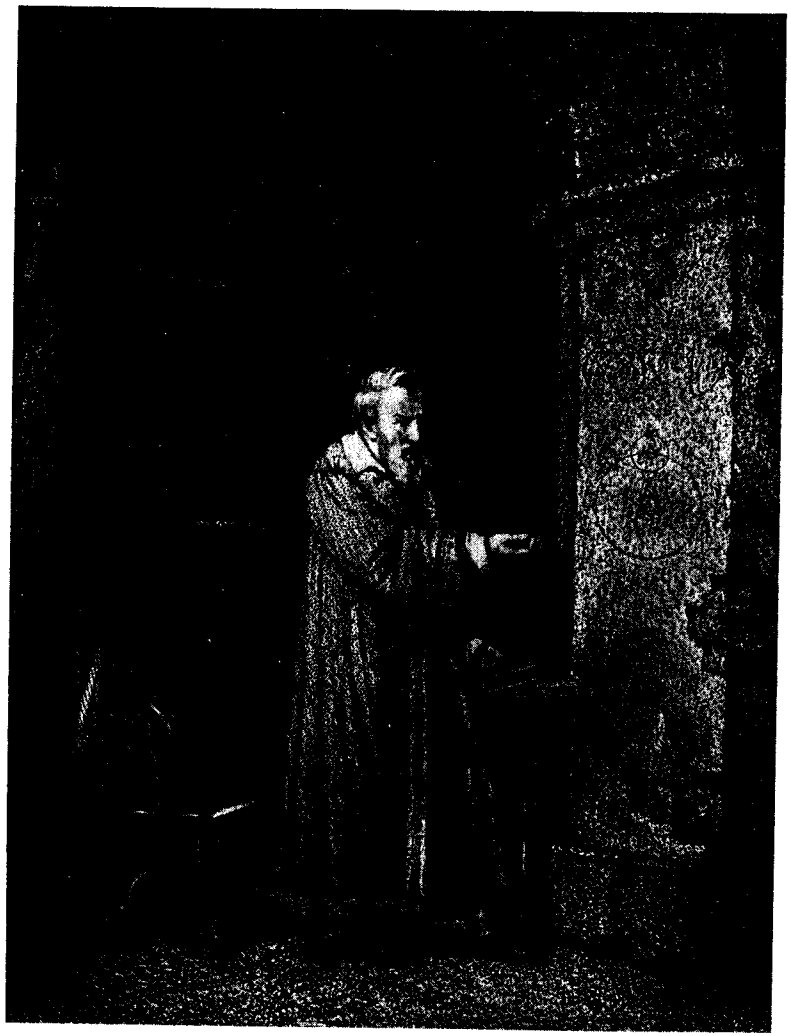

Culver Pictures

From: Makers of the Western Tradition: Portraits from History, 5th ed., New York, St. Martin's, 1991, pp. 266-288.

THE CRIME OF GALILEO

1564	Born
1592	Became professor of mathematics, University of Padua
1610	Invented Galilean telescope
1632	Published *A Dialogue Concerning the Two Chief World Systems*
1633	Condemned by Inquisition
1642	Died

In the opening years of the seventeenth century, Galileo Galilei was one of the most famous people in the world. Since 1592 he had been professor of mathematics at the great University of Padua, and in 1610 he became "first philosopher and mathematician" to the grand duke of Tuscany, Cosimo dei Medici, who had been his tutorial student. He was the familiar of princes, wealthy patricians, high officials of the church, and other scientists and mathematicians all over Europe. He was the principal advocate in Italy for the new natural philosophy, the usual name for the scientific interests that were beginning to become a passion with scientists and laymen alike.

In 1609 Galileo had heard about the development of a primitive perspective instrument by some Dutch spectacle makers that made distant objects appear larger and nearer. He built such an instrument himself and promptly improved its magnification so dramatically that it could be used for practical astronomical observation. He had invented the Galilean telescope. He observed the surface of the moon, the phases of Venus, the moons of Jupiter, the first hint of Saturn's rings, the phenomenon of sunspots, and that the Milky Way was actually a collection of enormously distant stars. In the following year, he published these observations in a little pamphlet volume entitled *Sidereus nuncius* [The Starry Messenger]. It was an instant sensation.

Even more exciting to Galileo than his astronomical discoveries was the support they clearly gave to the Copernican theory of the universe—that the sun and not the earth was its center and that the planets, including the earth, rotated around the sun, "the lamp that illumines the whole universe." Galileo had long believed in the validity of the rational and mathematical arguments that Copernicus had put forward in 1543 in his *De revolutionibus orbium coelestium.* Galileo had corresponded with his great German contemporary, the astronomer Johannes Kepler, also a dedicated Copernican, and had been free in letters to friends and colleagues in his espousal of the Copernican theory. He eagerly entered into a number of controversies with conservative academics who refused to accept the truth or consequences of his astronomical observations. In a dispute over the nature of sunspots in 1612, Galileo, in defending his own views on these phenomena, publicly and in print unequivocally endorsed the Copernican theory.

But by this time the Copernican theory was running into serious trouble, and so was Galileo. The Copernican theory was not simply a theory that one was free or not to accept—at least not in Catholic countries. For the church had long since accepted the older Ptolemaic model of the earth-centered universe, and it had become an integral part of the official Catholic theology. Thus the whole issue of Copernicanism became not merely an astronomical and mathematical proposition; it was a religious issue, and a dangerous one. The new Catholic attitude of the early seventeenth century was that of the Counter Reformation church, the revived and militant church prepared more than ever to defend its ancient truths. There was little disposition to accommodate radical new views that stood in opposition to established doctrine, and even less disposition to tolerate those who held such radical views. Moreover, from 1613 to 1615, in a series of published letters—actually treatises—Galileo had tried to defend the new sciences generally and the Copernican theory specifically in arguments that were as much theological as they were scientific. He was a loyal son of the church, and he wanted passionately to prevent its making a tragic error in this entire matter of the new theory of the universe.

But it became increasingly clear that the church was moving the other way. Galileo went himself to Rome early in 1615 to defend Copernicanism. He was courteously enough received by great churchmen, some of whom listened to him patiently and a few of whom supported his views. But then, on February 25, 1616, after a careful examination by a committee of theologians, the doctrine of Copernicus was formally condemned by the Congregation of the Index, summoned by Pope Paul V himself. It would have been condemned out of

hand as heretical except for Galileo's friend, Cardinal Maffeo Barberini, who intervened to have it declared simply "erroneous in the faith." But what about Galileo? He was not only a vocal and celebrated advocate of the now condemned theory, but he had already been denounced to the Inquisition by a number of his enemies. At the pope's own order he was summoned, on the day following the decree, to appear before Cardinal Bellarmine, the chief theologian of the church, and told that he must neither "hold nor defend" the theory of Copernicus.

Galileo returned to Florence heartbroken. He kept silent on the issue for the next seven years and devoted himself to noncontroversial work. Then in 1623 Maffeo Barberini, his longtime friend and supporter, was elected Pope Urban VIII. Galileo hastened to Rome, confident that he could secure the revocation of the decree of 1616 and gain permission to write the great book he had long planned, "*On the System or Constitution of the World,* an immense design, full of philosophy, astronomy, and geometry."[1] He was wrong on both counts. The pope refused to reverse the condemnation of the Copernican theory. Moreover, failing totally to understand what Galileo really wanted, he would permit him to write about the constitution of the world only if he would write about both the Copernican system and the Ptolemaic and if he did not presume to choose between them.

Galileo agreed, and in 1632 he published his *Dialogue Concerning the Two Chief World Systems—Ptolemaic and Copernican.*

[1]From a letter to Belisario Vinta quoted in Galileo Galilei, *Dialogue on the Great World Systems,* ed. Giorgio de Santillana (Chicago: University of Chicago Press, 1953), Historical Introduction, p. xi.

The Two Chief World Systems

GALILEO GALILEI

The idea of a great, far-ranging work on the nature of the universe as seen in Copernican terms had long obsessed Galileo. He had mentioned it in 1597 in a letter to Kepler. In 1610, in the Starry Messenger, *he had referred to it as a forthcoming book. And references to it continued to crop up in his writings. But that was all changed by the pope's injunction of 1624. He would have to write a quite different book. He struggled with it, delayed by illness and family responsibilities. It was finally completed in January 1630, and he began the task of getting it licensed by the church to be printed. Rome delayed for almost two years and finally, under pressure from the Florentine ambassador, granted the imprimatur, with some trifling revisions to the title page. Florentine church authorities had already given their approval. The book, published in Florence on February 21, 1632, took the form of a dialogue with three participants. Filippo Salviati, a Florentine nobleman, friend, and supporter of Galileo, was represented as the advocate for Copernicanism. An imaginary character, Simplicio, was the defender of the Ptolemaic-Aristotelian traditional arguments. And the Venetian patrician Giovanni Sagredo, uncommitted to either view, was the audience to whom the other two addressed themselves. It was set in Sagredo's palace in Venice and ran through four days of conversation.*

The book was an immediate success despite its large size, its abstruse subject, and its formidable mathematics. Within five months every copy was sold. In large part it was successful because it was controversial. In clear and unmistakable violation of the ban of the church, Galileo defended the Copernican theory—and boldly said as much in his preface. In the dialogue itself, the arguments of Simplicio for the Ptolemaic view are systematically and enthusiastically demolished. At the very end of the dialogue, there is a weak and perfunctory admission by both disputants that no one can "limit and restrict the Divine power or wisdom to some particular fancy of his own" or really "discover the work of His hands." It was no more than the merest lip service to the demand that the pope had made of Galileo.

Here is Galileo's preface.

Several years ago there was published in Rome a salutary edict which, in order to obviate the dangerous tendencies of our present age, imposed a seasonable silence upon the Pythagorean opinion that the

earth moves.[2] There were those who impudently asserted that this decree had its origin not in judicious inquiry, but in passion none too well informed. Complaints were to be heard that advisers who were totally unskilled at astronomical observations ought not to clip the wings of reflective intellects by means of rash prohibitions.

Upon hearing such carping insolence, my zeal could not be contained. Being thoroughly informed about that prudent determination, I decided to appear openly in the theater of the world as a witness of the sober truth. I was at that time in Rome; I was not only received by the most eminent prelates of that Court, but had their applause; indeed, this decree was not published without some previous notice of it having been given to me. Therefore I propose in the present work to show to foreign nations that as much is understood of this matter in Italy, and particularly in Rome, as transalpine diligence can ever have imagined. Collecting all the reflections that properly concern the Copernican system, I shall make it known that everything was brought before the attention of the Roman censorship, and that there proceed from this clime not only dogmas for the welfare of the soul, but ingenious discoveries for the delight of the mind as well.

To this end I have taken the Copernican side in the discourse, proceeding as with a pure mathematical hypothesis and striving by every artifice to represent it as superior to supposing the earth motionless—not, indeed, absolutely, but as against the arguments of some professed Peripatetics.[3] These men indeed deserve not even that name, for they do not walk about; they are content to adore the shadows, philosophizing not with due circumspection but merely from having memorized a few ill-understood principles. . . .

In the course of the third day, we find the most outspoken defense of Copernicus. Salviati is speaking:

. . . I have often seen Jupiter and Venus together, twenty-five or thirty degrees from the sun, the sky being very dark. Venus would appear eight or even ten times as large as Jupiter when looked at with the naked eye. But seen afterward through a telescope, Jupiter's disc would be seen to be actually four or more times as large as Venus. Yet the liveliness of Venus's brillance was incomparably greater than the pale light of Jupiter, which comes about only because Jupiter is very

[2]It was believed by Galileo, as earlier by Copernicus, that the ancient Greek heliocentric theory—probably actually first enunciated by Aristarchus—was one of the teachings of Pythagoras.—ED.

[3]The usual name for Aristotelians which is to say, in this context, defenders of the Ptolemaic theory. The term literally means "those who walk about."—ED.

distant from the sun and from us, while Venus is close to us and to the sun.

These things having been explained, it will not be difficult to understand how it might be that Mars, when in opposition to the sun and therefore seven or more times as close to the earth as when it is near conjunction, looks to us scarcely four or five times as large in the former state as in the latter. Nothing but irradiation is the cause of this. For if we deprive it of the adventitious rays we shall find it enlarged in exactly the proper ratio. And to remove its head of hair from it, the telescope is the unique and supreme means. Enlarging its disc nine hundred or a thousand times, it causes this to be seen bare and bounded like that of the moon, and in the two positions varying in exactly the proper proportion.

Next in Venus, which at its evening conjunction when it is beneath the sun ought to look almost forty times as large as in its morning conjunction, and is seen as not even doubled, it happens in addition to the effects of irradiation that it is sickle-shaped, and its horns, besides being very thin, receive the sun's light obliquely and therefore very weakly. So that because it is small and feeble, it makes its irradiations less ample and lively than when it shows itself to us with its entire hemisphere lighted. But the telescope plainly shows us its horns to be as bounded and distinct as those of the moon, and they are seen to belong to a very large circle, in a ratio almost forty times as great as the same disc when it is beyond the sun, toward the end of its morning appearances.

SAGR. O Nicholas Copernicus, what a pleasure it would have been for you to see this part of your system confirmed by so clear an experiment!

SALV. Yes, but how much less would his sublime intellect be celebrated among the learned! For as I said before, we may see that with reason as his guide he resolutely continued to affirm what sensible experience seemed to contradict. I cannot get over my amazement that he was constantly willing to persist in saying that Venus might go around the sun and be more than six times as far from us at one time as at another, and still look always equal, when it should have appeared forty times larger.

SAGR. I believe then that in Jupiter, Saturn, and Mercury one ought also to see differences of size corresponding exactly to their varying distances.

SALV. In the two outer planets I have observed this with precision in almost every one of the past twenty-two years. In Mercury no observations of importance can be made, since it does not allow itself to be seen except at its maximum angles with the sun, in which the inequalities of its distances from the earth are imperceptible. Hence such

differences are unobservable, and so are its changes of shape, which must certainly take place as in Venus. But when we do see it, it would necessarily show itself to us in the shape of a semicircle, just as Venus does at its maximum angles, though its disc is so small and its brilliance so lively that the power of the telescope is not sufficient to strip off its hair so that it may appear completely shorn.

It remains for us to remove what would seem to be a great objection to the motion of the earth. This is that though all the planets turn about the sun, the earth alone is not solitary like the others but goes together in the company of the moon and the whole elemental sphere around the sun in one year, while at the same time the moon moves around the earth every month. Here one must once more exclaim over and exalt the admirable perspicacity of Copernicus, and simultaneously regret his misfortune at not being alive in our day. For now Jupiter removes this apparent anomaly of the earth and moon moving conjointly. We see Jupiter, like another earth, going around the sun in twelve years accompanied not by one but by four moons, together with everything that may be contained within the orbits of its four satellites.

SAGR. And what is the reason for your calling the four Jovian planets "moons"?

SALV. That is what they would appear to be to anyone who saw them from Jupiter. For they are dark in themselves, and receive their light from the sun; this is obvious from their being eclipsed when they enter into the cone of Jupiter's shadow. And since only that hemisphere of theirs is illuminated which faces the sun, they always look entirely illuminated to us who are outside their orbits and closer to the sun; but to anyone on Jupiter they would look completely lighted only when they were at the highest points of their circles. In the lowest part—that is, when between Jupiter and the sun—they would appear horned from Jupiter. In a word, they would make for Jovians the same changes of shape which the moon makes for us Terrestrials.

Now you see how admirably these three notes harmonize with the Copernican system, when at first they seemed so discordant with it. From this, Simplicio will be much better able to see with what great probability one may conclude that not the earth, but the sun, is the center of rotation of the planets. And since this amounts to placing the earth among the world bodies which indubitably move about the sun (above Mercury and Venus but beneath Saturn, Jupiter, and Mars), why will it not likewise be probable, or perhaps even necessary, to admit that it also goes around? . . .[4]

[4]The Copernican theory not only described the earth's planetary movement but its rotation. The Ptolemaic, of course, held that neither kind of motion existed.—ED.

SIMP. But what anomalies are there in the Ptolemaic arrangement which are not matched by greater ones in the Copernican?

SALV. The illnesses are in Ptolemy, and the cures for them in Copernicus. First of all, do not all philosophical schools hold it to be a great impropriety for a body having a natural circular movement to move irregularly with respect to its own center and regularly around another point?[5] Yet Ptolemy's structure is composed of such uneven movements, while in the Copernican system each movement is equable around its own center. With Ptolemy it is necessary to assign to the celestial bodies contrary movements, and make everything move from east to west and at the same time from west to east, whereas with Copernicus all celestial revolutions are in one direction, from west to east. And what are we to say of the apparent movement of a planet, so uneven that it not only goes fast at one time and slow at another, but sometimes stops entirely and even goes backward a long way after doing so? To save these appearances, Ptolemy introduces vast epicycles, adapting them one by one to each planet, with certain rules about incongruous motions—all of which can be done away with by one very simple motion of the earth. Do you not think it extremely absurd, Simplicio, that in Ptolemy's construction where all planets are assigned their own orbits, one above another, it should be necessary to say that Mars, placed above the sun's sphere, often falls so far that it breaks through the sun's orb, descends below this and gets closer to the earth than the body of the sun is, and then a little later soars immeasurably above it? Yet these and other anomalies are cured by a single and simple annual movement of the earth. . . .

At the end of the discourse of the fourth day, there occurs the weak disclaimer of both systems. Salviati is speaking again:

To you, Sagredo, though during my arguments you have shown yourself satisfied with some of my ideas and have approved them highly, I say that I take this to have arisen partly from their novelty rather than from their certainty, and even more from your courteous wish to afford me by your assent that pleasure which one naturally feels at the approbation and praise of what is one's own. And as you have obligated me to you by your urbanity, so Simplicio has pleased me by his ingenuity. Indeed, I have become very fond of him for his constancy in sustaining so forcibly and so undauntedly the doctrines of his master. And I thank you, Sagredo, for your most courteous motivation, just as I ask pardon of Simplicio if I have offended him sometimes with my too heated and opinionated speech. Be sure that in this I have not been moved by any ulterior purpose, but only by that of giving you every opportunity to introduce lofty thoughts, that I might be better informed.

[5]Galileo was apparently unaware of his friend Kepler's theory about the elliptical orbits of the planets. But even if he did know about it, he never accepted the notion himself.—ED.

SIMP. You need not make any excuses; they are superfluous, and especially so to me, who, being accustomed to public debates, have heard disputants countless times not merely grow angry and get excited at each other, but even break out into insulting speech and sometimes come very close to blows.

As to the discourses we have held, and especially this last one concerning the reasons for the ebbing and flowing of the ocean, I am really not entirely convinced,[6] but from such feeble ideas of the matter as I have formed, I admit that your thoughts seem to me more ingenious than many others I have heard. I do not therefore consider them true and conclusive; indeed, keeping always before my mind's eye a most solid doctrine that I once heard from a most eminent and learned person, and before which one must fall silent, I know that if asked whether God in His infinite power and wisdom could have conferred upon the watery element its observed reciprocating motion using some other means than moving its containing vessels, both of you would reply that He could have, and that He would have known how to do this in many ways which are unthinkable to our minds. From this I forthwith conclude that, this being so, it would be excessive boldness for anyone to limit and restrict the Divine power and wisdom to some particular fancy of his own.

SALV. An admirable and angelic doctrine, and well in accord with another one, also Divine, which, while it grants to us the right to argue about the constitution of the universe (perhaps in order that the working of the human mind shall not be curtailed or made lazy) adds that we cannot discover the work of His hands. Let us, then, exercise these activities permitted to us and ordained by God, that we may recognize and thereby so much the more admire His greatness, however much less fit we may find ourselves to penetrate the profound depths of His infinite wisdom.

[6]Much of the argument of the day had been devoted to Galileo's theory that the ocean tides were related to the rotation of the earth—a mistaken notion.—ED.

The Crime of Galileo

GIORGIO DE SANTILLANA

The pope was furious. He had every reason to believe he had been betrayed by Galileo's Dialogue. *Galileo's enemies were clamoring for his condemnation. The process of an inquiry by the Inquisition was begun, and in less than a year Galileo was summoned to Rome to stand trial. In June 1633 he was judged to have held and taught the Copernican theory, against the teachings of the church. This was the crime of Galileo. He was ordered to recant and did so. The normal sentence of life imprisonment was commuted to house arrest by the pope, and Galileo was permitted to return to his estate near Florence where he lived and worked for the remaining eight years of his life.*

His "crime" remains the center of the Galileo biography. Why did he do it? It was not an unwitting or accidental transgression. It was a clear and willful act of defiance. Was he courting martyrdom? Nothing in his behavior before or during his trial suggests it. One can only conclude that the vindication of his ideas was an important enough issue for the risk involved. And what risk did he take? He had obviously violated the spirit of the pope's instructions about the Dialogue, *but his book had been licensed by the pope's own censors in Rome and Galileo could claim that he had legally abided by the pope's instructions—no matter how badly.*

But there was another set of instructions, going back to the original condemnation of Copernicanism in 1616 and Galileo's interview with Cardinal Bellarmine. What had he been told or not told by the cardinal? It is clear that when the judgment of the Inquisition was finally made, Galileo was surprised and outraged at the severity of the sentence. Why? Because he had reason to believe he had stayed within the letter of the church's law on the matter. Two documents had turned up in the course of the trial, both having to do with the crucial interview with Bellarmine. One was in the Inquisition's file and was an official minute by its commissary general stating that he had been present at the interview and had personally warned Galileo not to hold or teach the theory of Copernicus "in any way whatsoever." Galileo claimed to know nothing about such a warning. And he, in turn, produced a certified copy of Cardinal Bellarmine's considerably milder charge to him. If the one document was a surprise to Galileo, the other was a surprise to the court. Bellarmine's certificate had not become a part of the record. Given this ambiguity, Galileo had reason to expect leniency, indeed,

may have been promised leniency if he would simply recant. But the case had become as much a trial for the church as for Galileo, and he had to be made an example. Hence the severity of his sentence.

By most accounts, the crux of Galileo's trial and the charges against him was that now remote interview with Cardinal Bellarmine seventeen years before, and the conflicting documents. Many scholars have speculated about this matter. We excerpt opinions by two of the leading modern Galileo scholars. The first is that of Giorgio de Santillana from his book The Crime of Galileo.

What can be the conclusion concerning that famous injunction of 1616? It is, and will remain to the end, the kingpin of the case. With it, from the legal aspect, the trial stands or falls. It came to our notice how everything connected with it was being surrounded all along with a screen of vague, reticent, or misleading language so as to protect it from indiscreet curiosity.

Some curiosity is therefore in order. We are going to review the evidence, starting from the two critical documents. . . . One of them is the injunction; the other is Bellarmine's certificate.

"Friday, the twenty-sixth [of February]. At the palace, the usual residence of the Lord Cardinal Bellarmino, the said Galileo, having been summoned and being present before the said Lord Cardinal, was, in presence of the Most Reverend Michelangelo Segizi of Lodi, O.P., Commissary-General of the Holy Office, by the said Cardinal, warned of the error of the aforesaid opinion and admonished to abandon it; and immediately thereafter, before me and before witnesses, the Lord Cardinal being still present, the said Galileo was by the said Commissary commanded and enjoined, in the name of His Holiness the Pope and the whole Congregation of the Holy Office, to relinquish altogether said opinion that the Sun is the center of the world and immovable and that the Earth moves; nor further to hold, teach, or defend it in any way whatsoever, verbally or in writing; otherwise proceedings would be taken against him in the Holy Office; which injunction the said Galileo acquiesced in and promised to obey. Done at Rome, in the place aforesaid, in the presence of R. Bandino Nores and Agostino Mongardo, members of the household of said Cardinal, witnesses."

"We, Roberto Cardinal Bellarmino, having heard that it is calumniously reported that Signor Galileo Galilei has in our hand abjured and has also been punished with salutary penance, and being requested to state the truth as to this, declare that the said Signor Galileo has not adjured, either in our hand, or the hand of any other

person here in Rome, or anywhere else, so far as we know, any opinion or doctrine held by him; neither has any salutary penance been imposed on him; but that only the declaration made by the Holy Father and published by the Sacred Congregation of the Index has been notified to him, wherein it is set forth that the doctrine attributed to Copernicus, that the Earth moves around the Sun and that the Sun is stationary in the center of the world and does not move from east to west, is contrary to the Holy Scriptures and therefore cannot be defended or held. In witness whereof we have written and subscribed these presents with our hand this twenty-sixth day of May, 1616."

. . . The first document looks gravely irregular both as to form and as to its place in the file; [and] the instructions of the Congregation to Bellarmine, as well as Bellarmine's subsequent report on what he had done that day, agree with his certificate and *not* with the injunction; and . . . there was in fact no allowable ground for an injunction as things stood.

We have seen further that in his most carefully considered piece of writing, the Preface to the *Dialogue,* Galileo deliberately mentions the famous audience as a signal distinction. He is actually calling the authorities to witness against the rumors that had been spread of a secret recantation. This would have been to provoke them foolishly if he had not been quite assured that things stood, in fact, so.

The natural supposition is that the record was hastily fabricated in 1632 when the authorities were trying to get a case against Galileo. . . .

Thus the matter stood for decades; it seemed suspended pending new evidence. This came eventually, not from any document, but from new physical means of analysis. In 1927 Laemmel, with the cooperation of the Vatican authorities, submitted the doubtful page first to soft X-rays and then to the much more rigorous test of the Hanau ultraviolet lamp. The result left no doubt on one point at least: the pages had never been tampered with. . . . The text is in exactly the same hand as other neighboring and certainly genuine documents; hence, it was written at or about the same time. To this we can add a clinching argument: the contemporary pagination shows that the original, if there ever was one, never got into the file; and therefore the decision to replace it with a falsification must have been taken then and there.

Still, there is something that remains hard to explain. The operation is curiously botched. The lack of an original alone might be construed as a mishap, for an inserted double sheet may drop out, but the wrong substitute job in the wrong place is painfully lasting evidence. A regular judge would have had to throw out the injunction

on that evidence alone; even the judges of 1633 did not dare rely too much on it.

Should one see here plain cynical disregard for regularity? We would doubt it very much. Regularity was a fetish with the administration, and any such detectable irregularity always entailed a risk for its author. It would almost look as though the thing had been done by someone not in full control of events and having to make shift with what he had. Even so, from a Commissary-General able to arrange things at his will, one might expect more resourceful solutions. . . .

So there might remain a point of doubt. Let us check our conclusions as they stand by assuming the opposite to be true, namely, that things happened as written and that Galileo really stands guilty of violating his instructions. We would then have to say that the protocol was accidentally lost as soon as made out; that the official doing the pagination never noticed its absence; that someone noticed it soon afterward; and that it was deemed sufficient to insert a transcription which can only have been done from memory, for, if the original had been available somewhere, it would have been put back into place. It does not sound very convincing.

Thus we are led back perforce to our version, and the question why the operation was carried out so and not otherwise turns out to be simply a statement of the Commissary's best judgment, based upon what he thought could be done and could not be done. The straight fact that emerges is that it was not held to be quite essential to have the protocol—or, rather, that, following Bellarmine's audience, it was deemed better to have no protocol at all rather than an authentic version of that audience. And so we may be led to conclude that the Commissary simply decided to do without one. Regularity has its limits. But, it would seem, falsification has too.

We know that there had been a strong tension in 1616 between the higher authorities who had decided on diplomacy and the Dominicans, bent at that time on repression. Vatican quarters several times hinted to Guicciardini that "the monks" were relentless. We may then reconstruct as follows: The Commissary, as he watched the scene (we know he was present), was disgusted with the easy way in which Galileo was let off, and he decided to omit the protocol, although his instructions were clear, and the witnesses already designated, obviously by the Cardinal himself. On going back to his office, he told his assistant to arrange a more helpful minute of the proceedings. "And," he may have added, "make it stiff, just in case. What they don't know doesn't hurt them; when trouble arises, it is we who have to take it on." Or it may be, of course, that the assistant, Father Tinti, did the job on his own initiative. But it seems very unlikely. This theory would have the merit of explaining naturally why the protocol was omitted

from the pagination as well as accounting for the other facts in the case.

To look at that silent sheet now, after three centuries, gives one a strange feeling, as though it were trying to tell us something. The first part, which reproduces the papal decree, is dealt out with well-practiced smoothness. As soon as it comes to the injunction, the lines get closer, and the writing becomes less legible, as though the writer were unconsciously trying to duck.

The falsification as such is, then, beyond doubt—truly, by modern standards, an exceedingly modest one. Father Segizi would never have dared forge a protocol. He had done a little something, the least he could do, in order to provide a toehold for prosecution if that were needed. . . .

Going back to Galileo, we can see that the course of events agrees with our previous conclusion. For not only, as we have shown, did Galileo feel completely confident that the officials were mistaken when the matter was finally revealed to him (and that would have been rather the time for him to grovel) but those very officials demonstrated, by their manner of handling the procedure of injunction when it was really necessary (viz., in order to summon Galileo to Rome), the elaborate context of rules in which such an act is framed. Here was a man who had patently fooled them, who was now subtly evading and challenging them; and yet a whole contraption had to be worked out in order to have something that would serve for an injunction without a previous refusal to motivate it. . . .

In the light of these later events it appears all the more incongruous that in 1616, when all was still clear, the Commissary should have sprung forward brandishing his threat *incontinenti,* as soon as Bellarmine had considerately informed Galileo that his theory had been found wrong, without even giving him the time to declare his acquiescence to the new ruling.

These problems really all reflect to the credit of the institution. In fear of its own absolute and unlimited powers, it had framed for itself such a rigid set of rules that, when the need came for cutting corners, it could not do so by merely stretching the interpretation. As a result, certain officials, who held the view that when a job has to be done it has to be done, did not shrink from altering the records without the acquiescence of their superiors. . . .

To maintain that Bellarmine himself was a party to the deceit ought to be out of the question. The operation seems to begin and end in the office of the Commissary-General of the time, Father Michelangelo Segizi, among those implacable Dominicans to whom Guicciardini alludes, "fired with holy zeal" [and] convinced that mathematicians are a tool of the Devil, who thought it an excellent precaution

against the Adversary to put in this pretended registration. No one need be deceived by it if he did not want to, they thought; and, meanwhile, here was a trap to snare the Evil One in case of need. As it happened, it was Pope Urban and the Congregation who were to be snared in it. . . .

It might still be asked, finally: Why did Galileo in person never pronounce himself explicitly on the subject? He was the man to know. Well, we do have a fairly explicit statement from him—as explicit as he could make it without contempt of court. . . . He told the judges that he would not recite the formula of abjuration, even at the risk of dire penalties, *if it contained anything implying that he had ever deceived his censors and specifically in the matter of extorting a license.* And in fact it does not, although the sentence was built upon this specific accusation, and hence a penitential admission was in order. But, if he does *not* admit that he did "artfully and cunningly" refrain from telling about the injunction, then Galileo is saying as clearly as he can, in the face of the authorities, that the injunction never existed. And this ought to answer the question.

A Historical Speculation

STILLMAN DRAKE

Giorgio de Santillana argues in the foregoing passage that the injunction forbidding Galileo "to hold, teach, or defend . . . in any way whatsoever, verbally or in writing" the theory of Copernicus was a forgery, done by or at the bidding of Father Michelangelo Segizi, the commissary general of the Inquisition.

In the following excerpt, Stillman Drake, the principal translator of Galileo's writings and an acknowledged authority on Galileo, maintains that the disputed document is not a forgery. Rather, he sees it as a case of bureaucratic inertia, a notation routinely made, duly filed, and forgotten for seventeen years. He makes his case in what he calls "a historical speculation," a reconstruction of what must have happened in the background of "one of the most dramatic trials in history."

Two theories have long prevailed concerning the events of February 26, 1616, when Galileo was called before Cardinal Bellarmine and admonished to abandon the Copernican theory. Either theory has

strong points in its favor and equally strong objections. One theory places Galileo in a good light and the Church in a bad one; the other reverses this. Competent scholars for nearly a century—that is, since all the known documents have been opened to examination and publication—have taken one side or the other, or have scrupulously withheld judgment. No real third alternative, to the best of my knowledge, has been put forth. . . .

. . . Everything seems to hinge upon the reliability of one crucial document, the copy of a supposed minute of the proceedings, bound into the official records used by the Inquisition at Galileo's trial in 1633. Advocates of the theory, which places Galileo in a good light, led in recent years by Professor Santillana, regard this document as a fabrication, a spurious account that includes events which never took place. This entails certain difficulties, for the minute has precisely the same authority as most of the documents which must be accepted in order to reconstruct the events. But this apparent disadvantage is not fatal, since the adversaries of this view labor under similar difficulties. In accepting the minute at its face value, they in turn are constrained to give a labored explanation of the existence or meaning of two or three documents of unquestioned authenticity. . . .

The two received theories appear to be poles apart, especially when considered in terms of the fundamental question whether the minute itself is true or false. Any third alternative may seem preposterous. Yet I shall advance the thesis that another theory is tenable; furthermore, that in the light of this theory, neither of the two prevalent interpretations is far from the truth, nor are they so far apart as they have previously seemed to be. . . .

In the winter of 1615–1616, Galileo debated often and publicly at Rome on the topic of the earth's motion. In these debates he succeeded in demolishing the position of his opponents, even if he did not win many converts to his own views. It was an inevitable consequence of his position that certain statements in the Bible would have to be reinterpreted. Now, freedom to interpret the Bible was a sore point with Catholic authorities at the time; this was one of the particular issues between them and the founders of various Protestant sects. Hence Galileo's plea that the Church continue to tolerate the teachings of Copernicus was one that could not be readily granted.

Though personally unsympathetic with the intellectuals of his time, Pope Paul V was cautious about alienating this influential group. Accordingly he consulted Cardinal Bellarmine, who was not only the leading theologian at Rome but was also an able administrator. As theologian, Bellarmine remarked that so long as astronomers took the idea of the earth's motion only hypothetically, there was no overt contradiction of the Bible; as administrator, he maintained that it was always a poor idea for the Church to take an official position on any matter where decision could be postponed or avoided. The Pope replied that he was aware of all this, but that Galileo was making an infernal nuisance of himself and had forced matters to a point where some official action had to be taken. In that event, answered Bellarmine, it would be necessary to stop all theological discussions of the earth's motion and to correct or suppress any books containing theological arguments in its favor. The proper procedure would be to submit the question to a duly constituted committee of theologians and to base official action on their ruling, the nature of which was easily predictable. Galileo, he was certain, would obey such an edict as a good Catholic; and since he alone was the present source of difficulty, the problem would be solved without the actual prohibition of Copernicanism. To make sure of this, however, he would undertake to test Galileo's obedience privately before the edict was published, and if there were any doubt about his cooperation, stronger measures could be applied. In view of the strong support Galileo enjoyed politically, intellectually, and in Church circles, it would be good to avoid the appearance of any personal or vindictive action in the matter.

Satisfied with Bellarmine's advice, the Pope appointed a council which duly reported its findings against the doctrine of the motion of the earth and stability of the sun. On the twenty-fifth of February, 1616, the Pope specifically instructed Bellarmine to call Galileo before him and admonished him to abandon these views as contrary to Scripture. If he refused, then the Commissary General of the Inquisition was to command him in the presence of a notary and witnesses to desist from such teachings, lest he be imprisoned. It is perfectly clear from the wording of this order that two separate actions were contemplated, the second to ensue only if the first failed; and it is equally clear that the presence of a notary and witnesses would be entirely out of place at the first action, which was to be informal and friendly in character.

Seghizzi, the Commissary General, was present when the Pope gave these instructions. He belonged to the Dominican order, which traditionally had charge of the Inquisition. He did not particularly like or trust the Jesuits, who had usurped the role of the Dominicans as leaders in Catholic education, and he was especially distrustful of the relatively liberal views of Bellarmine. Accordingly he decided to be personally present at Bellarmine's interview with Galileo, in order to make sure that if Galileo did object, Bellarmine would not reason with him and win him over rather than subject him to official action by the Inquisition. Thus on the morning of the twenty-sixth, shortly after Bellarmine had dispatched two of his familiars (special officers of arrest attached to the household of each Cardinal Inquisitor) to

fetch Galileo, Seghizzi with a notary and some Dominican fathers paid a visit to Bellarmine's residence.

The visit was unusual, and Bellarmine quickly guessed its true purpose, which was personally offensive to him. At his age, and in his high position, he did not need any lesser officials present to see that he carried out his assignment properly. Still, there was no tactful way to get rid of them, and he could scarcely order them out of his house. Before long, the arrival of the officers with Galileo was announced. Bellarmine rose and went to the door of the audience chamber to greet Galileo, hat in hand, as was his custom with every guest of whatever condition. Indignant at Seghizzi's abuse of his hospitality and determined to render it pointless, he said in low tones to Galileo as they turned to enter, "His Holiness expects your precise obedience to what I am about to tell you." Then they returned together to the Gardinal's chair, and after seating himself, Bellarmine benignly announced to Galileo the decision of the council and admonished him to obey it.

Meanwhile, Seghizzi was thinking rapidly. He was no fool, and he guessed easily enough that Bellarmine had warned Galileo to voice no objection. Thus he had not only been outwitted, but by the very act of coming uninvited he had cut off any chance, however slight, that Galileo might be recalcitrant and that Bellarmine would turn him over to the Inquisition. Time was running out. There was only one way to save the day. When the Cardinal had finished his admonition, the Commissary was ready. Without allowing Galileo time for any reply, he proceeded to deliver his own stringent precept not to hold, defend, or teach Copernicanism in any way, orally or in writing, lest Galileo suffer imprisonment. The latter, forewarned, simply replied that as a good son of the Holy Church he would obey, perhaps adding that he was relieved to know that the matter had at last been settled by superhuman authority, and thanking the Cardinal for his having given him advance notice of the edict that would soon be published.

The notary, sublimely ignorant of the Pope's instructions, was faithfully recording these events, and had written that the Commissary "immediately and without holding back" had delivered his precept on the heels of the Cardinal's admonition. Bellarmine was astonished and exasperated at this further affront to his dignity and clear disobedience of the Pope's orders by the Commissary. But he knew precisely what to do. Taking Galileo by the arm and ushering him to the door, he said that he was pleased by his submission to the Church, and that at another time he wished to speak further with him, but that he had important business to discuss with the others and could not detain him longer that day. If Seghizzi tried to interrupt, the Cardinal

quelled him with a glance. When Galileo was safely out of doors, he returned and asked the Commissary to confer with him privately.

Seghizzi may have begun the conference by angrily remonstrating against Galileo's having been permitted to leave without signing the notary's account of the interview. Bellarmine replied that it would have done little good for Galileo to sign this, since he himself had not the slightest intention of putting his name to a wholly illegal proceeding in direct violation of the Pope's orders. Seghizzi would do well to destroy this minute, he said. If the Pope were ever told precisely what had happened, he would be much incensed. . . .

Bellarmine gave his report to the Pope and the Cardinals of the Inquisition on March third precisely as if his own admonition were all that had been given to Galileo. Seghizzi, who was present, said not a word. The Pope then gave instructions for publication of the edict. . . .

In 1632, when the *Dialogue* was finally published and sent to Rome, the principal persons involved in the proceedings of 1616 were all dead except Galileo. The cardinals and officers of the Inquisition in 1633 had no reason whatever to doubt the authenticity of the copied minute as a faithful account of the instructions given to Galileo in 1616. Thus the rage of Pope Urban VIII, who had been Galileo's friend, is not hard to understand. It appeared to him that Galileo had persuaded him to permit publication of an "impartial" discussion of the Ptolemaic and Copernican theories, while concealing from him a specific injunction never to teach the latter theory in any way. On the other hand, Galileo was not aware of any misdeed, for he had faithfully followed Bellarmine's instruction to remember only his admonition, treating all else as if it had never happened. Nor did Galileo suspect that the official records belied this instruction, for Bellarmine had been a Cardinal of the Inquisition and presumably had had authority to keep the record consistent with his own affidavit.

Thus was the ground laid for one of the most dramatic trials in history. At its outset, both sides were acting in good faith. When Galileo was interrogated about the events of 1616, he gave precisely the account that Bellarmine had told him to give, and he produced a copy of Bellarmine's certificate in support of this, adding that he could produce the original if required. Considering that none of the inquisitors could possibly have suspected the existence of such a document, it must indeed have created a sensation in the mind of the new Commissary, Maculano. However, he calmly entered it in the record and proceeded with his examination. Galileo frankly admitted that some Dominican fathers were present on the occasion of the interview, but said he did not remember that any of them spoke to him. . . .

Maculano now pursued the question by asking whether, if he should

read to Galileo what had actually been said at the time, Galileo would recall it. Galileo stood his ground resolutely, saying that he had frankly stated his recollection, and that he did not know that such a reading would alter his memory. Maculano then read to him the additional phrase "or teach in any way," and asked him if he remembered who had said this to him. Galileo reiterated that he did not recall anything having been said to him except by Cardinal Bellarmine. But for the first time, he now realized what the records must contain, and it was already too late for him to admit that anyone else had spoken to him. . . . Nor could Galileo's judges admit that he had been accused on the basis of a defective document in their own records.

Nevertheless, these men were judges and jurors of a strict tribunal, and they could not ignore the evidential value of Galileo's document. It is true that on April seventeenth, a committee of experts had found that Galileo had at least defended Copernicanism in the *Dialogue,* so that if the inquisitors were to drop the charge that he had been enjoined not to teach it in any way, he could still be found guilty of defending it. But no one wanted to drop the original charge at the cost of impugning the official records. . . .

It is apparent . . . that the trial was resumed only after Galileo had been induced to "cop a plea"; that is, had been promised a light sentence if he would cooperate by confessing to some lesser crime than that with which he was originally charged. It was a fair deal for both sides. Galileo could not hope to get off scot-free, and the inquisitors, with any kind of confession from him, could ignore the preponderance of the weight of Galileo's evidence over theirs on the crucial charge. Galileo's confession was duly handed in on April thirtieth. He said in effect that vanity had induced him to produce arguments of his own in favor of Copernicus without providing equally strong answers, but he insisted that there had been no wrong intention on his part. His defense, presented ten days later, explained the circumstances under which he had secured the affidavit from Bellarmine and stated that ". . . the two phrases in addition to 'hold' and 'defend,' which are 'teach' and 'in any way,' which I hear are contained in the command given to me and recorded, came to me as entirely new and [previously] unheard, and I do not think I should be doubted if in the course of fourteen or sixteen years they were lost to my memory. . . ."

At the end of April, the intention had been to make Galileo's punishment very light: probably a short term of imprisonment and some conventional religious penances. . . . But by the time the Cardinals of the Inquisition met again to pass sentence, at least one among them must have doubted the wisdom of letting him off lightly. . . . The only solution was to keep Galileo under physical arrest, while making the conditions of his detention easy for him. So long as he remained in the custody of the Inquisition, he would not dare breathe a word against that institution or in favor of Copernicanism, for the penalty against "relapsed heretics" was death.

Suggestions for Further Reading

There are two standard modern editions of Galileo's *Dialogue,* the one excerpted for this chapter, Galileo Galilei, *Dialogue Concerning the Two Chief World Systems—Ptolemaic and Copernican,* tr. and ed. Stillman Drake, foreword by Albert Einstein, 2nd ed. (Berkeley and Los Angeles: University of California Press, 1967), which is an entirely new translation and edition; and Galileo Galilei, *Dialogue on the Great World Systems,* in the Salusbury translation, rev. and ed. Giorgio de Santillana (Chicago: University of Chicago Press, 1953), which is a revised and annotated edition of the translation by the Englishman Thomas Salusbury in 1661. An anthology of Galileo's earlier writings, leading up to the *Dialogue,* is *Discoveries and Opinions of Galileo,* tr. and ed. Stillman Drake (New York: Doubleday, 1957). There are also two modern editions of Galileo's last major publication, *The Two New Sciences,* a treatise on mechanics and motion also written in dialogue form, which most authorities consider his most important scientific work. One is based on the definitive Italian national edition of 1913 by Antonio Favoro, *Dialogues concerning Two New Sciences,* tr. Henry Crew and Alfonso de Salvio (Evanston: Northwestern University Press, 1950); the other is a totally new edition and translation, Galileo Galilei, *Two New Sciences,* tr. and ed. Stillman Drake (Madison: University of Wisconsin Press, 1974). And there are recent editions of two of Galileo's earliest writings, both edited by Stillman Drake: *Cause, Experiment, and Science: A Galilean Dialogue Incorporating a New English Translation of Galileo's "Bodies That Stay Atop Water and Move in It"* (Chicago: University of Chicago Press, 1981) and *Telescopes, Tides, and Tactics: A Galilean Dialogue About the "Starry Messenger" and Systems of the World* (Chicago: University of Chicago Press, 1983). Most of the documents relative to Galileo's trial are either excerpted or reproduced in Karl von Gebler, *Galileo Galilei and the Roman Curia,* tr. Mrs. George Sturge (London: C. K. Paul, 1879; rpt. 1977).

Few figures have been so much revised and reappraised as Galileo. There are three works (among many) that have collected reflective essays on him: *Homage to Galileo,* Papers presented at the Galileo Quadricentennial, University of Rochester, October 8 and 9, 1964, ed. Morton F. Kaplon (Cambridge: M.I.T. Press, 1965); *Galileo Reappraised,* ed. Carlo L. Golino (Berkeley and Los Angeles: University of California

Press, 1966); and *Galileo, Man of Science*, ed. Ernan McMullin (New York and London: Basic Books, 1967).

The best treatment of Galileo as a scientist is Stillman Drake, *Galileo at Work: His Scientific Biography* (Chicago and London: University of Chicago Press, 1978). There is also a detailed critique of his *Dialogue on the Two World Sytems*, William R. Shea, *Galileo's Intellectual Revolution* (London: Macmillan, 1972). The best biography is probably still Giorgio de Santillana, *The Crime of Galileo* (Chicago: University of Chicago Press, 1955). But the best brief biography is surely Stillman Drake, *Galileo* "Past Masters Series" (New York: Hill and Wang, 1981). The slightly more general work by Ludovico Geymonat, *Galileo Galilei: A biography and inquiry into his philosophy of science*, tr. and ed. Stillman Drake (New York, Toronto, and London: McGraw-Hill, 1965), is also recommended. Pietro Redondi, *Galileo Heretic*, tr. Raymond Rosenthal (Princeton, N.J.: Princeton University Press, 1987) is a brilliant and exciting revisionist account of Galileo's "crime." Students may be interested in a book by the brilliant and provocative popularizer Arthur Koestler, *The Sleep Walkers: A history of man's changing vision of the universe* (New York: Macmillan, 1968 [1959]), which ends with an account and assessment of the work of Galileo and Newton.

A Modern Version of Galileo's Argument

Suppose (as Aristotle believed) that the heavier a body is, the faster it falls to the ground and suppose that we have two bodies, a heavy one called [M] and a light one called [m]. Under our initial assumption [M] will fall faster than [m]. Now suppose that [M] and [m] are joined together thus [m/M]. Now what happens? Well, [m/M] is heavier than [M] so by our initial assumption it should fall *faster* than [M] alone. But in the joined body [m/M], [m] and [M] will each tend to fall just as fast as before they were joined, so [m] will act as a 'brake' on [M] and [m/M] will fall *slower* than [M] alone. Hence it follows from our initial assumption that [m/M] will fall both *faster* and *slower* than [M] alone. Since this is absurd our initial assumption must be *false*.

From: Alec Fisher, The Logic of Real Arguments, Cambridge, Cambridge University Press, 1988, pp. 1, 91.

III An application of the revised method: an example from Galileo

The test of what we have said is whether it works with real arguments – with arguments which have actually been used – so we now apply it to a famous piece of reasoning due to Galileo. We gave a modern version of Galileo's argument on p. 1, but we now look at his original argument. It comes from his *Dialogues Concerning Two New Sciences* and it is given in its full context as exercise 10, pp. 167–70.

In the early seventeenth century there was a tradition deriving from Aristotle (and therefore generally believed) that heavier bodies fell to earth *faster* than lighter ones. As Galileo explains in our example (and speaking of bodies with the same shape),

> Aristotle declares that bodies of different weights in the same medium, travel (in so far as their motion depends upon gravity) with speeds which are proportional to their weights.

This is the claim which Galileo sets out to *refute* and he attempts to do so *not by experimenting with bodies of different weights* but by means of a beautiful piece of reasoning which treats Aristotle's claim as a supposition and which then draws out the implications of that supposition. As a preliminary to his argument Galileo accepts that 'each falling body acquires a definite speed fixed by nature' and he calls this its 'natural speed'. His argument then proceeds as follows,

> If we then take two bodies whose natural speeds are different, it is clear that on uniting the two, the more rapid one will be partly retarded by the slower, and the slower one will be somewhat hastened by the swifter . . .
>
> . . . But if this is true, and if a large stone moves with a speed of, say, eight while a smaller moves with a speed of four, then when they are united, the system will move with a speed less than eight; but the two stones when tied together make a stone larger than that which before moved with a speed of eight. Hence the heavier body moves with less speed than the lighter; an effect which is contrary to your supposition. Thus, you see how from your assumption that the heavier body moves more rapidly than the lighter one, I infer that the heavier body moves more slowly.