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The Interplay of Science and Rhetoric in Seventeenth Century Italy

During the early part of the seventeenth century in Italy a revolution took place in the way that rhetoric was used to foster acceptance of a scientific theory. The interest of philosophers and theologians in Copernicus's *De revolutionibus*, published in 1543, provided the occasion for a debate that raged throughout the following century. Although the book was criticized by the Pope's theologian shortly after it appeared, the Church did not take a stand on the issue until 1616.[1] When Galileo took up the question in print and when others debated it and corollary issues with him in the same medium, they fortunately left for us a remarkable record of the way in which scientific demonstration yielded to dialectic and to rhetoric as means of gaining assent to a scientific theory.

The accepted method for proving a scientific theory in this period, as in the Middle Ages, was scientific demonstration according to the principles established by Aristotle. In the scholastic understanding, scientific reasoning or demonstration results in certainty. Usually expressed in the form of a syllogism, the prem-

[1] As early as 1544, Tolosani, a Dominican theologian and Master of the Sacred Palace advised against the work, but he did not live long enough to see that the book was condemned as he wished. See Eugenio Garin, *Rinascite e revoluzioni. Movimenti culturali dal XIV al XVIII secolo* (Bari: Laterza, 1976), pp. 255–281 and 283–295.

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ises of a demonstration are based on sense experience or true principles, and they are concerned with true causes of phenomena. Dialectical reasoning is termed probable reasoning because it treats matters where certainty is impossible; thus its premises are based upon what is commonly thought to happen, or what is true generally and for the most part. (For purposes of simplification, I pass over the use of dialectical reasoning to establish the principles of a science, a point Aristotle mentions in the first chapter of the *Topics*.) Rhetorical reasoning is, similarly, probable reasoning, and it is primarily concerned with contingent matters. Its premises also rest on opinion, but it differs from dialectic in using ethical and pathetic proofs and in frequently employing figures to convey and enhance its message.

In the case of the Copernican system, the verifiable evidence was only partially available to Galileo.[2] For this reason, Galileo used dialectical or probable reasoning, enthymematic arguments, ethical, and pathetic appeals to persuade his audience to accept the Copernican theory as the best explanation of the cosmic system. His writings were quite persuasive for readers weary of scholastic syllogizing, but for the traditional scientists of the day his arguments, while persuasive, were not convincing. For them, the eminent philosopher-mathematician had failed to prove his case.

In this paper I would like first to make more explicit what I mean by a revolution in rhetoric and look briefly at some emphases in the teaching of rhetoric in Italy that probably influenced the rhetorical techniques of Galileo and his opponents. Finally, I would like to sample some of the rhetorical strategies used by Galileo, by

[2]Not until the early nineteenth century was unassailable proof available of the earth's motion around the sun. This was provided by stellar parallax, measured by Bessel and others. Furthermore, the daily rotation of the earth could not be proved by Aristotelian canons of scientific reasoning until experiments with a large pendulum were performed by Foucault in the mid-nineteenth century. I have discussed the implications of this situation for Galileo's defense of the Copernican system in "Galileo's *Letter to Christina:* Some Rhetorical Considerations," *Renaissance Quarterly* 36 (Winter 1983), 547–586; "Galileo's Rhetorical Strategies in Defence of Copernicanism," *Novita celesti e crisi del sapere*, Paolo Galluzzi, ed. (Florence: Istituto e Museo di Storia della Scienza, 1983), pp. 95–103; and "The Rhetoric of Proof in Galileo's Writings on the Copernican System," in *The Galileo Affair: A Meeting of Faith and Science*, eds. G. V. Coyne, M. Heller, and J. Zycinski (Vatican City: The Vatican Observatory, 1985), 41–65, reprinted in *Reinterpreting Galileo*, W. A. Wallace, ed. (Washington, D.C.: The Catholic University of America P, 1986), 179–204.

a disciple of his, Mario Guiducci, and by one of Galileo's chief opponents, Orazio Grassi, during the early stages of the Copernican debate.

By rhetorical revolution, I mean a new transposition of rhetorical and scientific proofs in theory claims, whereby scientific demonstration is relegated to a subsidiary position in the advancement of a scientific theory. Instead, dialectical and rhetorical reasoning and rhetorical appeals substitute for scientific proof when scientific evidence is insufficient to create a demonstration. This rhetorical revolution was not a conscious attempt to break with the past, but rather a broadening into the domains of science of the rifts in the Aristotelian system emerging centuries earlier. The interjection of rhetoric into scientific discourse probably began shortly after the sightings of "novelties" in the heavens—the nova of 1572 and 1604, the discoveries of Galileo with the telescope, and the comets of 1618. These phenomena called into question the reigning view of the cosmos and aroused interest in Copernicus's proposal of a heliocentric explanation. The wide interest of the educated public made what would normally have been an abstruse topic disputed in academe alone a subject for public debate as well. The inventive treatments of the subject that followed, employing vivid metaphors, analogies, and a variety of other rhetorical figures, made them as entertaining as they were instructive. But what began as rhetorical framing and embellishment prepared the way for the more radical replacement of demonstration by rhetorical argument.

To show that I am not claiming too much for the role of demonstration in science, let us see what some of the participants in the debate about the Copernican theory say explicitly about the proper method for scientific reasoning. The clear demarcation between scientific demonstration and rhetorical argument and the province of each, I have indicated above, was certainly understood and accepted by the intellectual community in which Galileo lived and worked. Both Galileo and Cardinal Robert Bellarmine in their early discussions of the Copernican thesis articulate precisely the nature of scientific demonstration.

Bellarmine, in April of 1615, almost a year before the expurgation of *De revolutionibus* was ordered by the Church, sketched out in a letter to Paolo Antonio Foscarini the canons of proof that would be acceptable to the Church. Foscarini, a Carmelite father, had asked Bellarmine for his opinion regarding a small treatise in defense of Copernicanism that he, Foscarini, recently had pub-

lished. The work called for a reinterpretation of Scriptural passages in the light of Galileo's discoveries with the telescope.[3] The Cardinal commends both Galileo and Foscarini for speaking "hypothetically" and not "positively," as he has "always believed Copernicus did." He adds that if there were a "true demonstration that the sun was at the center of the universe" and that "the sun did not go around the earth but the earth went around the sun" then the Church would have to alter its reading of the Scriptures. He adds, "I do not think there is any such demonstration, since none has been shown to me." It is one thing to show that "the appearances are saved" and another "to demonstrate that in fact the sun is in the center and the earth in the heavens." Thus, when there are doubts "one may not abandon the Holy Scriptures as expounded by the holy Fathers," he points out.[4]

For his part Galileo acknowledges also that demonstration was the proper mode of proof in a private letter he addressed to Bishop Dini:

> To me the surest and swiftest way to prove that the position of Copernicus is not contrary to Scripture would be to give a host of proofs that it is true and that the contrary cannot be maintained at all.[5]

But what of rhetoric? Did Galileo have an equal understanding of the nature of rhetoric? My own research shows that he was probably well trained in rhetorical method. At about age twelve, Galileo was enrolled in the school of Santa Maria at Vallombrosa, where he stayed until 1580 or 1581.[6] Although I have found no roster

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[3]The letter is translated by Stillman Drake in *Discoveries and Opinions of Galileo* (New York: Doubleday Anchor Books, 1957), 162–164. The literature on Galileo and the Copernican question is enormous. Some of the works most germane to this essay but not otherwise referenced herein are the following: Thomas Kuhn, *The Copernican Revolution* (Cambridge: Harvard UP, 1957); Arthur Koestler, *The Sleepwalkers* (New York: Macmillan, 1959); Jerome Langford, *Galileo, Science and the Church* (Ann Arbor: U of Michigan P, 1976).

[4]Bellarmine's letter is in the National Edition of Galileo's works, *Le Opere di Galileo Galilei* (referred to hereafter as *Opere*), ed. Antonio Favaro, 20 vols. in 21 (Florence, 1890–1900, rpt. 1968), XII, 173. I have quoted from Stillman Drake's translation in *Discoveries*, pp. 162–165.

[5]*Opere* XII, 185, quoted from *Discoveries*, p. 166.

[6]For particulars of Galileo's life see Ludovico Geymonat, *Galileo Galilei: A Biography and Inquiry into his Philosophy of Science*, S. Drake, tr. (New York: McGraw Hill, 1965), pp. 9–15. See also Stillman Drake, *Galileo at Work: His Scientific Biography* (Chicago: U of Chicago P, 1978).

of the courses or the teachers there, I was able to examine the library catalog of Vallombrosa, dated 1790, in the Biblioteca Nazionale in Florence. The catalog shows that the monks had extensive holdings in rhetoric from that period. Several editions of Aristotle's *Rhetoric*, Cicero's epistles and orations as well as his works on rhetoric, and Quintilian's *Institutiones* were all contained in that collection as well as many contemporary commentaries. Other circumstantial evidence includes Galileo's translation into Latin of a passage from Isocrates, probably done at Vallombrosa or at the University of Pisa, which he entered about 1581.[7] Records for courses and faculty at Pisa are more substantial. There, an illustrious faculty taught during the period—Francesco Robortello, Ciriaco Strozzi, Pietro Angelio Bargeo, and Aldo Manucci. From the writings of these professors and the course descriptions we can surmise that Galileo had a thorough immersion in the *studia humanitatis*, which embraced grammar, poetics, rhetoric, history, and moral philosophy.[8] Thus, he would have had a thorough instruction in Ciceronian rhetoric and exposure to the text of Aristotle's *Rhetoric*. But one has only to look at Galileo's writings themselves to find proof of his mastery of principles of poetic and rhetoric.

Galileo's understanding of the province of rhetoric and its relation to logic and dialectic may have come through his acquaintance with Jesuit teachings on logic and science. As Professor Wallace has documented in recent articles and books, Galileo was well acquainted with Jesuit lectures on logic at their Collegio Romano. Galileo carefully copied and summarized Jesuit lecture notes on logic which were later published by Ludovico Carbone, a priest who was once a student there.[9] What is less well known is that the same Carbone also published a number of works on rhetoric.[10] In

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[7]The text of Isocrates is preserved in *Opere* IX, 283–284.

[8]Records consulted are in the Archivio di Stato of Pisa.

[9]For a full general discussion see Wallace, *Galileo and His Sources: The Contribution of the Collegio Romano* (Princeton: Princeton UP, 1984); Wallace reveals here that Carbone appropriated Jesuit notes and published them under his own name, pp. 16–19. See also his pointed brief study, "Galileo's Sources: Manuscripts or Printed Works?" *Print and Culture in the Renaissance*, eds., Gerald P. Tyson and Sylvia S. Wagonheim (Newark: U of Delaware P, 1986), pp. 45–54.

[10]I have described these works in "The Rhetoric Course at the Collegio Romano in the Latter Half of the Sixteenth Century." *Rhetorica*, 4 (Spring 1986), 137–151. In another article, I have given examples of the close ties of rhetoric with philosophy and dialectic in Jesuit teaching, "Invention in the Italian Renaissance," *Visions of*

the preface to his *De Arte Rhetorica* (1589), Carbone mentions that he is especially indebted to his Jesuit professors and that he has tried to publish the fruits of their teaching in his books.[11] Whether Galileo was also familiar with Carbone's writings on rhetoric or the lecture notes of the Jesuits on which these were based is an open question. What one may say is that the scholastic emphasis on logic and dialectic as a foundation for rhetoric must have been known to him as it certainly was to the Jesuits who were his most vociferous opponents. This conjunction of the two disciplines was not confined to Jesuit schools. In the schools of religious orders and in many universities, Aristotelian logic remained an important part of the training of scholars. There, dialectical method, disputation, and the close links of these to rhetoric were valued.[12]

By this point in its history, the disputation had become "humanized" so that in the hands of Galileo's opponent Orazio Grassi, for example, it was delivered in an informal manner, with some artful rhetorical flourishes, even though its intent was to examine the nature and orbits of some recently observed comets.

Before turning to the debate with Grassi, however, I would like to describe the way in which rhetoric is employed in Galileo's earliest writings on the Copernican thesis. *The Siderius Nuncius*, or *The Starry Messenger* as Stillman Drake has translated the title, was published in 1610, and it brought the author immediate fame.[13] Galileo

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Rhetoric: History, Theory and Criticism. Charles W. Kneupper, ed. (Arlington, Texas: Rhetoric Society of America, 1987), 30–41. These essays document a departure from the trends of rhetoric instruction during this period noted by Cesare Vasoli, *La dialettica e la retorica dell'Umanesimo* (Milan: Feltrinelli, 1986). See also the account of rhetoric and professors of rhetoric in the recent work of A. Scaglione, *The Liberal Arts and the Jesuit College System* (Philadelphia: John Benjamins Company, 1986). Marc Fumaroli treats Carbone's writings on sacred oratory in *L'Age d'Eloquence* (Geneva: Librarie Droz, 1980), 182–186.

[11] The book is a guide (*tabula*) and commentary on *De arte rhetorica* (1568) of the Jesuit Cipriano Soarez, whose text was used into the eighteenth century in Jesuit colleges. Lawrence C. Flynn has translated and noted the commentaries on Soarez's text, but he evidently was not aware of Carbone's work, "The *De Arte Rhetorica* of Cyprian Soarez, S. J.: A Translation with Introduction and Notes," diss., U of Florida, 1955.

[12] Neal Ward Gilbert has written an excellent analysis of attitudes toward the disputation and its relation to science in the period: "The Early Italian Humanists and Disputation," *Renaissance Essays in Honor of Hans Baron*. A. Molho and J. A. Tedeschi, eds. (Florence: Sansoni, 1971); and *Renaissance Concepts of Method* (New York: Columbia UP, 1960).

[13] I have used Drake's translation in *Discoveries*, pp. 21–58.

relates in it the marvels he discovered when he turned the telescope on the heavens. We can feel his excitement as he realizes that the moon is not composed of that mysterious fifth element, the quintessence, and that it is not the perfect sphere of received science. Although Galileo uses poetic language and metaphor and even rhetorical argument at times in his account, he is also careful to relate precisely what he has seen and to phrase his conclusions in a scientific manner. For example, his description of the spots on the moon is objective and precise:

> From observations of these spots repeated many times I have been led to the opinion and conviction that the surface of the moon is not smooth, uniform, and precisely spherical as a great number of philosophers believe it (and the other heavenly bodies) to be, but is uneven, rough, and full of cavities and prominences, being not unlike the face of the earth, relieved by chains of mountains and deep valleys.[14]

This is language his peers would think appropriate to a scientific treatise. The manner in which he begins to move into the realm of rhetoric is beautifully illustrated in a succeeding passage. There, having presented his reasons for concluding that the moon must be illuminated by the sun and that the earth's own reflection of the sun's light is what permits us to see the faint image of the rest of the moon when it is in its quarter phases, Galileo posits a rhetorical question:

> Yet what is so remarkable about this? The earth, in fair and grateful exchange, pays back to the moon an illumination similar to that which it receives from her throughout nearly all the darkest gloom of night.[15]

Here, although Galileo uses metaphor to convey his delight in finding an answer to an age-old question, he does so simply to reinforce the conclusion at which he has already arrived through premises based on concrete evidence. The whimsical conceit lends grace to his writing and underscores his findings, but it is not intended to serve as a serious causal argument.

A passage following closely on the above, however, does foreshadow the rhetorical arguments he will present five years later in the *Letter to the Grand Duchess Christina* and in the *Dialogue Concern-*

[14] Ibid., p. 31.
[15] Ibid., p. 44.

ing the Two Chief World Systems of 1632. In his projected book, the *System of the World,* he writes, he will treat more thoroughly the matter of the moon's being lighted by the earth:

> In that book, by a multitude of arguments and experiences, the solar reflection from the earth will be shown to be quite real—against those who argue that the earth must be excluded from the dancing whirl of stars for the specific reason that it is devoid of motion and of light. We shall prove the earth to be a wandering body surpassing the moon in splendor, and not the sink of all dull refuse of the universe; this we shall support by an infinitude of arguments drawn from nature.[16]

Galileo here uses to advantage the hubris of Renaissance man who gloried not only in his own powers but in the marvelous riches of the earth. This orb could now lay claim to a place among the planets, the wandering stars. Far from being inferior to the moon, it can claim more than equal status. These lines are designed to stir the emotions of his readers to accept the implications he has outlined, and they also encourage them to look forward to his projected book, where he claims all of the demonstrations will be laid out. The book he mentions here was no doubt the nucleus of the *Dialogue Concerning the Two Chief World Systems* (1632), which ultimately led to his trial.

The *Letter to the Grand Duchess Christina of Loraine,* written five years after *The Starry Messenger,* is in some ways Galileo's most audacious and fervent defense of that thesis. The *Letter* is Galileo's attempt to convince the "shadow audience," for whom he really wrote the letter, that Copernicus's book should not be condemned. He relies on rhetorical appeals and dialectical arguments to urge the Church to reinterpret scripture and not to ban the book because it contradicts some passages in the Bible. Although he does offer some evidence from his sightings with the telescope that could have been used in constructing a partial demonstration, this is not the full demonstration that would have been demanded as certain proof by scientists of the day. Galileo, however, goes on to refer to the importance of necessary demonstrations more than forty times in the letter. These repeated references bolster his claim that certain proof exists, and they become the foundation of his appeal to the ecclesiastical authorities for reinterpretation of the conflicting scriptural passages. The Church's position, as we have seen in Bellarmine's letter to Foscarini, was that if a necessary demonstration

[16] Ibid., p. 45.

were presented to show that the earth moves, then the Church would call for a reexamination of the Scripture. Aside from Galileo's assertion of a faulty minor premise that a necessary demonstration exists, the letter is a masterpiece of rhetorical and dialectical argument. Unfortunately, although the Grand Duchess, the titular audience of the letter may have been convinced, the clerical audience was not, and the church banned discussion of the system in 1616.[17] Henceforward, espousal of the Copernican thesis was not to be permitted, no doubt because ecclesiastical authorities believed the reinterpretation of Scripture this would require would further undermine Roman Catholic authority already damaged by Protestant successes.

By this time, dissatisfaction with the Ptolemaic explanation of the cosmos had led a number of scientists to espouse the Tychonic theory, that of Tycho Brahe. Brahe maintained that the planets did move around the sun, but that this group then together circled the earth. His theory explained the movements of the stars as observed with the telescope, which the Ptolemaic system could not, and, most importantly, it preserved the Scriptural texts.

When in 1618 three comets were seen in the heavens, there was an immediate outcry for an explanation of the phenomena and how they related to the rival explanations of the movements of the universe. An anonymous disputation, published in 1619 and entitled *An Astronomical Disputation On the Three Comets of the Year 1618,* attempted to explain the comets in accord with Tycho's system. The disputation, described on the title page as having been delivered publicly at the Collegio Romano, opened what was to become a heated exchange between Galileo and its author, who was Orazio Grassi, professor of mathematics at the college. The following examples of some of the rhetorical elements in the debate illustrate the increasing role of rhetoric in science.

The prologue of the disputation contains some pointed references to the discoveries of Galileo. "The human mind, Most Illustrious Ones, is so desirous of novelties that occasionally it grows weary of the long continuance of things which are good and desires to improve upon the situation." Grassi then recounts the new knowledge of the heavens that astronomical observation has yielded: the disfigurement of the moon's surface, the orbits of Venus, Mercury, and Mars, and the satellites of Jupiter and Saturn.

[17] "Galileo's *Letter to Christina,*" 569–576.

Only comets, he says, have evaded the notice of the "lynx-eyed."[18] The latter reference to the phenomenally sighted animal is an allusion to Galileo who was the most illustrious member of the famed Lincean Academy, begun by Prince Federico Cesi. Interestingly, the society was dedicated to the study and communication of scientific matters and determined to avoid rhetorical ceremony so common to other Italian academies.[19]

Grassi remarks that the sudden appearance of three comets in the year 1618, and one of these an exceedingly bright one, have turned men's attention to those phenomena and to the problem of their location—whether they are in the celestial or the sub-lunar regions. This is the major problem of the tract and one that Grassi says he will try to solve with mathematics and without entering into the popular controversies concerning the portents these are thought to embody. Although his avowed purpose is scientific, in typically humanistic fashion, Grassi displays his literary and rhetorical erudition in the process of unfolding his proofs. Departing from the practice of the scholastics, Grassi frames his disputation with a prologue and postscript, employs a narrative form to couch his proofs, and maintains an informal, conversational tone throughout. The Jesuit's description of the comets is replete with metaphors taken from the figures of the constellations. He speaks of one of the comets "licking the hind feet of the Great Bear," and using the *loci* of epideictic discourse, he organizes his account as follows:

> Since I believe that in this duty I ought not deviate from the masters of eloquence, in accordance with their practice, taking the first argument of my discourse from the comet's birth, I have sought its native land and parentage, and I have opened a pathway for myself through the illustrious circle of its subsequently famous life to the far from obscure character of its death.[20]

Grassi then observes that since the Sun and Mercury were "lodged together in Scorpio," they necessitated "a very elegant and splen-

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[18] *The Controversy on the Comets of 1618* (Philadelphia: U of Pennsylvania P, 1960), pp. 5–6. The disputation, as all of the publications in the debate, are translated by Stillman Drake and C. D. O'Malley in this volume.

[19] Stillman Drake comments on its anti-rhetorical stance, *Galileo at Work* (Chicago: U Chicago P, 1978), pp. 166–167; see also, Martha Ornstein, *The Role of Scientific Societies in the Seventeenth Century*, Chicago: U Chicago P, 1928), pp. 74–76.

[20] *Controversy*, p. 8.

did feast to be prepared for the guests and, as well, that a very bright torch be kindled." He calls the newly arrived comet "a foetus . . . offspring of Mercury."[21]

All of this description is simply an introduction to the major content of the disputation, a scientific demonstration in support of his theory that the comets are located beyond the moon, between it and the sun, and that they describe a circular orbit. In his carefully developed argument, Grassi offers the sightings of astronomers in other parts of Europe to ground his conclusion. He uses these and his own observations as the basis for establishing the geometric points and measurements offered in the demonstration. He concludes that this evidence enables him to say that "we may now determine almost the true place of the comet, let us say that it can probably be placed between the sun and the moon." Grassi says "probably" (*dicimus probabliter Solem inter ac Lunam illum statui posse*) in order not to claim absolute accuracy for the observations.[22] Unlike Galileo's tactics in the *Letter to Christina*, he has presented proof according to the canons of the day. The audience for whom he intends his discourse is obviously one composed of scholars and extends beyond the Collegio. The disputation ends with a graceful postscript summarizing its content: "I have believed that the comet, shining on all directly from the same place and appearing the same from all sides, must be considered as worthy of the heavens and very near to the stars." He expresses the hope that his audience of "distinguished gentlemen" will grant the motives of his reasoning to be lofty, and, as a final touch, appends a verse from Horace, "With my head exalted I shall touch the stars."[23]

Grassi's little book enables us to see first hand that the academic exercise of disputation has spawned a hybrid, a kind of *declamatio philosophiae naturalis*, a cross between an oration in epideictic mode and the formal, tightly ordered, closely-reasoned disputation that its title implies. I am not claiming that this is Grassi's innovation, but that his *Disputation* is an example of a marked change that has taken place in this period: the application of rhetoric, and even a rhetorical genre, to subjects in natural philosophy.

Galileo did not then publish his opinion on the comets himself

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[21] Ibid., pp. 9–10.

[22] Ibid., p. 11; *Opere* VI, 33, line 30–31.

[23] *Controversy*, pp. 18–19; Drake attributes the verse to Horace, *Carmina* I, i. 36, n. 16, p. 362.

but did so indirectly through one of his disciples, Mario Guiducci, consul of the Florentine Academy.[24] As consul, Guiducci felt obliged to give occasional public lectures and naturally wished to choose topics of current interest. Probably urged by Galileo, he decided to focus on the comets and the recently published disputation in particular, and in the process to give an account of the views of his esteemed friend. Guiducci delivered two lectures, which were printed in 1619 under the title *Discourse on the Comets*. This treatise the author dedicated to Leopold Archduke of Austria because of his interest in astronomy and because of the attention he paid to Galileo when he passed through Florence. Following his elegant tribute to the Grand Duke of Tuscany in the *Siderius Nuncius*, Galileo had been appointed chief mathematician and philosopher of the Tuscan Court by the Grand Duke and had moved to Florence, giving up his lesser paying position as a professor at the University of Padua. The dedication of the *Discourse* illustrates the international character of the audience for whom Guiducci and Grassi assume they are writing.

In the published text, Guiducci is somewhat sharp and sarcastic in his references to the Jesuits and to the author, even though Grassi had made no direct reference to Galileo or his views in his disputation, except for the passing reference to the comets having escaped the sight of the linx-eyed. Guiducci's opening remarks indicate that Galileo must have taken that comment personally. After an introductory observation about the powers of the human mind in reference to the secrets of the universe—by now a commonplace—Guiducci says that since only a short time has elapsed since the appearance of the comets no great blame should be attached to those philosophically enlightened elite who have not yet spoken about the phenomena. Grassi also had discussed the inability of the telescope to magnify distant objects and this seems to have been another source of Guiducci's and Galileo's displeasure.

Guiducci says he will first offer the opinions of ancient and modern astronomers, assess these, and then discuss the views of the Academician Galileo. Guiducci is careful to state that he simply

[24] Drake believes the *Discourse* to be actually Galileo's, basing his opinion on the evidence of Antonio Favaro, editor of Galileo's works, *Controversy*, xvi–xvii. Favaro pointed out that the manuscript of the work is mainly in the hand of Galileo except for passages written by Guiducci, and even these are corrected by Galileo. William R. Shea accepts this view in his discussion of the writings on the comets, *Galileo's Intellectual Revolution* (New York: Science History Publications, 1972), pp. 75–76.

intends here to offer "conjectures" of Galileo, and these "not positively but merely probably and with reservations."[25] In the course of his arguments Guiducci refutes many false opinions and fallacious arguments of Aristotle and exposes what he finds are the inadequacies of Tycho's observations about the orbits of the comets, saying in one place, "This savors more of poetic grace than of soundness and rigor, and deserves no consideration from you whatever, as Nature takes no delight in poetry."[26] Throughout, the Consul expresses his surprise that mathematicians at the Collegio (where he himself had studied) could have developed such faulty arguments and have accepted Tycho's position.

As Guiducci presents the views of his learned friend, Galileo conjectures that the comets are simply an optical illusion, that they do not move in orbits, but simply in straight lines perpendicular to the earth. The issue was a complex one. To say that the comets were in circular orbits above the moon was thought to be strong evidence for the Tychonic system, so Galileo through Guiducci was at pains to refute it. In sum, the *Discourse,* which is itself a disputation answering Grassi's, does not pretend to offer a demonstration; rather it posits arguments to counter Grassi's contentions and seeks to force him to prove that the comets are real.

The *Discourse* generated a reply from Grassi under the pseudonym of Lothario Sarsi Sigensani, an anagram of Orazio Grassi Savonensi.[27] (As a member of the Jesuit Order, Grassi was expected to refrain from public controversy on the matter and so withheld his identity.) The author directed his response to Galileo himself, dismissing Guiducci as a fictive author. Just as Galileo had used Guiducci as his intermediary, Sarsi says he will present the opinions of his master, Horatio (in the English translation) Grassi.[28] The reply is entitled *The Astronomical and Philosophical Balance* and purports to weigh the opinions of Galileo. Sarsi finds the tone and the attack on his mentor's reasoning immoderate, but says that he thinks he is in good company, since Galileo also dispatches Aristotle and Tycho among others. The author remarks that he cannot understand why Galileo would want to defame the good name of the Collegio and say that its teachers were "unskilled in logic." Sarsi-Grassi says he decided to continue the debate in order to

[25] *Controversy,* p. 24.
[26] Ibid., pp. 49–50.
[27] Shea, p. 83.
[28] *Controversy,* p. 70.

show that his arguments are not fallacious and to consider carefully the arguments presented on the other side. He adds, a bit self-righteously, "Furthermore, in this discussion, I shall constantly abstain from words which are more indicative of an exasperated and angry spirit than of knowledge, although I readily grant that method of reply to others if they desire it."[29] As for Guiducci-Galileo's accusation that Sarsi's master is content to follow Tycho's lead in these matters, Sarsi says that there is little in his *Disputation* that would warrant that conclusion; then he reverses the issue:

> But consider, let it be granted that my master adhered to Tycho. How much of a crime is that? Whom instead might he follow? Ptolemy? . . . . Or Copernicus? but he who is dutiful will rather call everyone away from him and will equally reject and spurn his recently condemned hypothesis. Therefore, Tycho remains as the only one whom we may approve as our leader among the unknown courses of the stars.[30]

The *Balance* contains three "weighings" or general headings under which the major propositions in the Guiducci-Galileo *Discourse* are considered. Sarsi first attempts to show that Grassi did not devalue the telescope at all, but that in fact the professors of the Collegio were among the first to welcome Galileo there and to applaud his discoveries. He then explains at greater length why he thinks the telescope does not enlarge distant objects as much as it does nearer ones. Since the comet is not magnified as much as the moon, it must be further away, he reasons. He next offers a number of arguments based on optics to show that the comet cannot simply be an illusion. There is not space here to develop in detail the defense of his position, but it is interesting to note that William Shea, a prominent historian of science, finds Grassi to be as right as Galileo in this exchange.[31]

After the appearance of the *Balance*, Guiducci felt it necessary to make an attempt to salvage his reputation as a scholar who was more than simply a mask for the revered Galileo. The response, interestingly enough, was published as a letter to Guiducci's former rhetoric professor at the Collegio Romano and entitled *Letter to the Very Reverend Father Tarquinio Galluzi of the Society of Jesus* (1620). The

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[29] Ibid.

[30] Ibid., p. 71.

[31] Shea, pp. 74–88. See also Wallace's analysis of the debate, *Galileo and His Sources*, pp. 295–298.

choice of audience is significant, I think, for our investigation. Evidently Guiducci was stung by the imputations of rudeness in Grassi's reply to his *Discourse* and by his statements that the consul had denigrated the education he had received at the Collegio. He is at pains to set the record straight and express the veneration he accords its professors. Protesting that he had simply desired to provide an example of oratory for the students of the academy, he asks that his old professor of rhetoric judge whether or not he was at fault in the way Grassi had suggested.

The most important exchange in the series is the longest and it was written by the master of persuasion himself, Galileo. *The Assayer* is cleverly and rhetorically conceived as a further "weighing," this time, as the long title discloses, in "a delicate and precise scale . . . the things contained in *The Astronomical and Philosophical Balance of Lothario Sarsi of Siguenza*." Galileo also cast his response in the form of a letter, addressed in this case to a member of the Lincean Academy, the Reverend Monsignore Don Virginio Cesarini, and "Lord Chamberlain to his Holiness" as the title page declares. The Academy published it in 1623 and the Academicians dedicated the work to the newly elected Pope, Urban VIII, later to become Galileo's implacable enemy.

In this piece there is no shadow author, but certainly there is a shadow audience beyond Cesarini himself, as publication of the work and its dedication imply. Galileo begins, as he did in the *Letter to Christina*, with a *captatio benevolentiae* wherein he describes the injustices done to him. There is, he says, "ill feeling and stubborn opposition against my works."[32] He declares himself to be much perturbed by Sarsi's ascription of the *Discourse* to him rather than to Guiducci, for anyone who knows Guiducci, he says, knows he is capable of such a work. But in a reversal of the point, he asks why, if he *had* wished to remain incognito, Sarsi should want to unmask him? And he declares that for his part he will respect the mask of Sarsi.[33] After the commonplace appeal to Cesarini's noble qualities and impartiality, Galileo turns to a very detailed refutation of each of the arguments presented by Grassi and does so in exhaustive detail. The reasoning is brilliant, the illustrations and analogies persuasive, and Galileo, as always, makes telling observations about the nature of science and the role of the scientist in

[32] *The Assayer* in *Controversy*, p. 168.
[33] Ibid., p. 170.

these philosophical debates. But he here, as elsewhere, often coats his ripostes with acid. In refuting a point of Sarsi's regarding the curved appearance of the tail of the comet, explained differently by Kepler and Guiducci (for Galileo), Galileo says

> Is it possible, Sig. Lothario, that you have allowed yourself to be so transported by the desire to obscure my name in the field of science, whatever it may amount to, as to disregard not only my reputation but even that of many of your friends? With errors and fictions, you have attempted to make them believe your teachings to be sound and sincere; by such means you have acquired their applause. But later, if they should ever happen to see this writing of mine and thereby come to understand how often and by what tricks you have treated them as simpletons, they will consider themselves to have been shabbily dealt with by you and the esteem and grace which you hold in their hearts will change its state and condition.[34]

In an aside to Cesarini concerning a proposition of Sarsi, he says:

> Read and reread it attentively; I say attentively so that you may the more plainly recognize afterward how craftily Sarsi still continues in his style of altering, deleting from, adding to, and even diverting the argument and mixing with it things that are alien to the subject, trying thus to confuse his readers' minds . .[35]

And about the Jesuits he remarks,

> He [Sarsi] cannot reasonably pretend that I should increase my debt and my affection toward people who make silly and false attributions and who threaten me with loss of their friendship because I reveal their errors by speaking the truth.[36]

The lengthy treatise passes beyond the dimensions of a letter, as Galileo himself observes, but he is determined to vanquish Grassi completely. The careful argumentation remains in the area of dialectic and does not venture to say that its arguments are necessary demonstrations or certain proofs. Galileo is determined to group Grassi with the worst of the scholastics of his day who are more convinced by arguments from authority than by sense evidence and mathematical demonstrations:

> It seems to me that I discern in Sarsi a firm belief that in philosophizing it is essential to support oneself upon the opinion of some

[34] Ibid., p. 272.
[35] Ibid., p. 314.
[36] Ibid., p. 211.

> celebrated author, as if when our minds are not wedded to the reasoning of some other person they ought to remain completely barren and sterile. Possibly he thinks that philosophy is a book of fiction created by some man, like the *Iliad* or *Orlando Furioso*—books in which the least important thing is whether what is written in them is true. Well, Sig. Sarsi, that is not the way matters stand. Philosophy is written in this grand book—I mean the universe—which stands continually open to our gaze, but it cannot be understood unless one first learns to comprehend the language and interpret the characters in which it is written. It is written in the language of mathematics, and its characters are triangles, circles, and other geometrical figures, without which it is humanly impossible to understand a single word of it; without these, one is wandering about in a dark labyrinth.[37]

This famous passage is one that has been extensively discussed for its reputed evidence of Platonism, but this is not my concern here; rather I quote it to illustrate Galileo's use of rhetoric to magnify his separation from the Peripatetics' extreme reliance on authority. Yet he shares with them the view that mathematical computations could provide certain proof. Whether these proofs can be applied to the realm of nature so as to yield necessary demonstrations is the problem. Grassi must have found the instruction directed to him, at the least, gratuitous since he was an excellent mathematician himself. His *Disputation*, in fact, contained a fine example of the very method Galileo was recommending to him in its use of parallax to prove the position of the comets. Moreover, his fellow Jesuit Giuseppe Biancani had written a treatise on the application of mathematics to problems in nature in 1615, long before Galileo's statement in the *Assayer*. Biancani noted in his treatise that mathematical demonstrations are *potissimae* and the best means of attaining certitude in the physical sciences.[38] In the case of the comets debated by Galileo and Grassi, the evidence is insufficient to justify a certain conclusion. As Galileo says regarding Guiducci's writing on this matter:

> Sig. Mario in his essay has never feigned anything, nor has he needed to do so, since whatever he has adduced that is new has always been

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[37] Ibid., p. 184.

[38] Biancani, like Grassi, studied under Christopher Clavius at the Collegio Romano. Clavius' course in mathematics was specifically designed to instruct students in the importance of that subject for the study of the physical world. It was he who said after the appearance of the nova of 1572 that the Peripatetics would have to revise their Aristotelian views of the matter of the heavens to account for the exis-

> set forth conjecturally and with reserve. He has not sought to make others accept as proved that which he and I take as questionable or at most as probable, and which we have arrived at and opened to the consideration of people more knowing than we in order to have their help either in drawing confirmations of some true conclusion or in completely excluding some false one.[39]

Because no definitive answers were forthcoming for either of the two contestants, both resorted to techniques of debate to gain an advantage: shifting ground, diverting the argument, claiming that important points were unknown or, more tellingly, deliberately disregarded.

Grassi was intent upon persuading his audience that the comets were real and that they were in the celestial regions even though his assertions denied the Aristotelian-Ptolemaic traditions still accepted by many Peripatetic academics. In defending his point of view, he used a mixture of arguments from authority as well as mathematical and empirical evidence. He was as adroit as Galileo in the tactics of argumentation, but he did not resort to rhetorical appeals to *replace* dialectical proofs to support his hypothesis. On the other hand, the stance that Galileo took regarding the comets William Shea has called that of a "conservative Aristotelian" leading to "a host of inconsistencies."[40] Shea finds the reason for Galileo's strategy in the comet debate to be his determination to show that Tycho Brahe's system was an inadequate substitution for the Ptolemaic:

> If the comets were real, then their path through space was a challenge to Copernicanism. The difficulty could be met, of course, by postulating a non-circular orbit, but Galileo was strenuously opposed to this idea. He chose rather to disclaim the existence of the comet and to reduce it to an optical phenomenon, to a case of refraction in vapours rising from the earth. This tenuous explanation stood little chance of being accepted unless he could show that Tycho had been completely wrong in what he stated about comets. He sought to achieve this by

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tence of the nova in the celestial realm where alterations were not expected to appear. The location of the nova Clavius conjectured through mathematical demonstration; see W. A. Wallace's account of Clavius and the nova in "Galileo's Early Arguments for Geocentrism and His Later Rejection of Them," *Novita Celesti e Crisi Del Sapere*, pp. 31–40; and Wallace's treatment of Biancani and the mathematical tradition at the Collegio in *Galileo and His Sources*, pp. 141–148.

[39] Ibid., p. 261.

[40] Shea, pp. 87–88.

> attacking Tycho on several fronts, and by using his consummate ability as a controversialist to destroy Tycho's prestige. . . . He criticised him for falling down from the high ideal of circularity and granting that the comet could move at an uneven speed along a non-circular path in a direction opposite to that of the other planets, but he glossed over the break-down of his own attempt to explain the progress of the comet by rectilinear motion. He deplored Tycho's failure to produce the work on astronomy that he had promised, but he did not mention that nine years had passed since he himself had announced in 1610 his intention of writing a treatise on the system of the world.[41]

The attack mounted by Galileo against Tycho was not convincing to those who favored Tycho or Ptolemy. They would be persuaded only by orthodox methods. Certainly Galileo was aware of this, and yet if so why did he advance the argument as he did? Shea thinks that he was greatly influenced by the Florentine Humanists who were opposed to all that savored of scholasticism. Their attitude "made room for free thought and original research but it also allowed rhetoric to pass muster for rational argument."[42]

There are two more pieces in this debate about the comets—a further reply by Grassi and a comment by Kepler—but these excerpts are sufficient to indicate the increasing role of rhetoric in the discussion of this issue.

In concluding this consideration of the interplay of science and rhetoric, I would like to turn to Galileo's long promised work, The *Dialogue Concerning the Two Chief World Systems.* It is his final attempt to gain recognition for Copernicus's theory as superior to the Ptolemaic in the face of the Church's decree forbidding Catholics to teach and to hold the theory. Since this complex and lengthy work would require an extended analysis, I will make only a few observations to underscore my contention that rhetoric was used in a revolutionary way during this period. As must be obvious by now, it is Galileo who employs rhetoric more liberally and imaginatively than the other authors I have treated. When he published the *Dialogue* twenty-two years after the *Starry Messenger,* Galileo could not argue openly for the Copernican system. Thus, he was careful to describe the argument of his *Dialogue* as a mathematical exercise with no intent to claim the Copernican view the stronger. These were only plausible arguments, not scientific demonstrations. As I have stated earlier, in reality Galileo could not do so; he lacked the

[41] Ibid., p. 87.
[42] Ibid., pp. 88–89.

crucial evidence to prove beyond a doubt what he suspected—that the earth moves and that it and the planets revolve around the sun. Nevertheless, whether Galileo *knew* at the time that he could not demonstrate the truth of the Copernican system is a subject still being debated. Some believe that he did think that his argument based upon the movement of the tides offered in the *Dialogue* was an adequate demonstration, that, as he had promised in the *Starry Messenger,* he could "prove the earth to be a wandering body." Others think that he knew it was not a "necessary demonstration," that he realized it was based on unproven assumptions. He simply gave it as another plausible but not convincing argument.[43]

Whatever the case, Galileo's *Dialogue* contains a multiplicity of rhetorical arguments. The decision to cast the work in the form of a dialogue was in itself a rhetorical strategy that enabled him to present his ideas as if they were an unbiased collaborative investigation of the issue. The cast of interlocutors was carefully staged so as to highlight the point of view Galileo espoused. The sage and witty Salviati, standing in for Galileo, provides the focus of the discussion by setting forth his opinions on the constitution of the heavens, outlining for the other two participants the evidence that has led him to his assumptions. Sagredo, his affable and sympathetic admirer, raises objections and doubts, but he is generally persuaded to see the wisdom of Salviati's reasoning. Simplicio, on the other hand, almost without exception provides dull-witted objections based on his blind adherence to the text of Aristotle. Through four days of discussion, the companions of Salviati are led to recognize the obvious superiority of the Copernican thesis. On the last day of the dialogue, in what has been called the "medicine at the end," Simplicio summarizes the whole of the deliberations to the effect that although Salviati's arguments have been ingenious, still man is powerless to know for certain what the real causes are behind the phenomena in God's creation.[44] As history has demon-

[43]Stillman Drake sees Galileo as seriously proposing the theory of the tides in "Reexamining Galileo's Dialogue" in *Reinterpreting Galileo,* pp. 155–175; Maurice Finocchiaro views the arguments as essentially hypothetical, *Galileo and the Art of Reasoning,* vol. 61, Boston Studies in the Philosophy of Science (Dordrecht: D. Reidel, 1980), p. 17; and W. A. Wallace thinks Galileo knew the proof was inconclusive, "Galileo's Science and the Trial of 1633," *The Wilson Quarterly* 7 (Summer 1983), 154–164.

[44]One of the main problems with this "medicine" was that it was put in the mouth of a simpleton, as Galileo's examiners in the trial noted. Furthermore the

strated, the presentation of the case was so convincing that it led to Galileo's conviction on the charge of teaching the forbidden thesis. Where the protestations of the preface and the testimony at the end failed in their purpose of convincing the audience that conviction on the issue was impossible, the rhetoric of the whole persuaded his enemies that Galileo actually intended the opposite.

Galileo's writings were the most influential of those we have examined and they were, undoubtedly, an important factor in legitimizing the use of rhetoric in the cause of science. His recognition that scientific demonstration eluded him led him to rely on the force of dialectical and rhetorical reasoning to sway the minds of his audience. Although he lost the scientific debate in the eyes of conservative scholars of the day, he won the decision in the eyes of many of his own and later generations.

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view was that espoused by the Pope. The examiners thought that it was not convincingly presented by Simplicio and too cooly received by the other participants in the dialogue. Karl von Gebler describes an audience granted by Pope Urban VIII to Galileo in which Urban expresses his views on the matter, *Galileo Galilei and the Roman Curia*, trans. Mrs. George Sturge (London: C. K. Paul & Co., 1879), pp. 116–117, 160; Giorgio de Santillana reconstructs the conversation there on the basis of documents, pp. 160–168. The examiners report is in *Opere* 19:348–360.