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Galileo as a Critic of the Arts

Aesthetic Attitude and Scientific Thought†

By Erwin Panofsky *

GALILEO, the son of a renowned musician and theorist of music, grew up in a humanistic rather than scientific environment and never lost his interest in art and literature. It is well known, for example, that he devoted "many months or even years" of patient labor to a comparison between Ariosto and Tasso, extolling the former and tearing the latter to pieces; and up to this day Tasso's biographers tend to be critical of Galileo because he failed to appreciate the greatness of Tasso, while Galileo's biographers tend to be critical of Tasso because he failed to live up to the standards of Galileo.

Not much attention, however, has been paid to the fact that Galileo's views on the other arts, though scattered about his writings rather than concentrated in one place, are no less outspoken than his views on poetry, and that from all his statements there emerges an aesthetic attitude no less consistent than — and possibly interrelated with — his scientific convictions.

I

Concrete evidence of Galileo's sympathy with art and artists is found in his life-long and truly reciprocal friendship with Lodovico Cigoli, the most important Florentine painter of his time (1559–1613). Cigoli collaborated with Galileo in collecting data on the sunspots and proclaimed his "loyal devotion" to his great friend in his last work, the frescoes in S. M. Maggiore (Fig. 1),††

† This paper, scheduled for delivery at the meeting of the History of Science Society at Washington on 30 December 1955 but not presented on account of illness, is a much abridged and somewhat revised version of a pamphlet, entitled *Galileo as a Critic of the Arts* (The Hague, 1954), to which the reader is referred for documentation. The publication of this version in *Isis* was suggested by the editor and may seem justifiable for two reasons. First, the original pamphlet, printed in a comparatively small edition and primarily addressed to historians of art and art criticism, may be difficult of access to many readers of *Isis*. Second, the author welcomes the opportunity of making certain additions and corrections — mostly suggested by Alexandre Koyré's "Attitude esthétique et pensée scientifique," *Critique*, IX (Tome XII, No. 100–101), 1955, p. 835 ff., and a number of personal communications — and is glad to comply with Professor Koyré's kind recommendation to clarify his purpose by the addition of a subtitle. Bibliographical references given in the original pamphlet have not been repeated, and the texts there quoted and translated *in extenso* have been here condensed and, in part, rendered somewhat more freely; the writer would like, however, to call attention to three annoying misprints (p. 22, Note 1, lines 4 and 6: "1519" and "1518" should read "1619" and "1618," respectively; *ibidem*, Note 2, line 2: "1901" should read "1891"). He also wishes to thank the Kunsthistorisch Instituut of Utrecht University for permission to publish the present abstract.

* The Institute for Advanced Study.

†† Illustrations referred to as Fig. 1, Fig. 2, . . . are to be found on the plates following p. 8. The inclusion of these plates has been made possible by the courtesy of the Institute for Advanced Study.

by placing the Assunta upon a moon depicted exactly as it had revealed itself to Galileo's telescope, complete with the "jagged dividing line" and the "many little islands," exactly as shown in the illustrations of the *Sidereus Nuncius* (Fig. 2) [1]; Galileo in turn rushed to Cigoli's assistance when the latter, then in Rome, had become involved in an art-theoretical discussion which had been going on for nearly two centuries. A modest man who felt that abstract speculation was "not his dish," Cigoli had asked Galileo to provide him with arguments against those who claimed that sculpture was superior to painting, and Galileo obliged with a long letter, dated 26 June 1612, the authenticity of which must be accepted for a number of reasons, among them the fact that the main argument is developed from an unquestionably authentic *propria manu* fragment.

This main argument is directed against the old contention that three-dimensional statues, having "relief" where two-dimensional paintings have none, were able to produce a more convincing illusion of reality. To this Galileo replies by an interesting anticipation of the modern distinction between "optical" and "tactical" values: there are two entirely different kinds of "relief," one deceiving the sense of touch, the other, the sense of vision. The deception of the sense of touch Galileo discards with an argument so utterly matter-of-fact as to seem trivial yet never before advanced in a discussion of this kind: nobody, when touching a statue, will ever believe that it is a living thing. Concerning the deception of the sense of vision, on the other hand, he contends that all optical effects fall within the province of the painter rather than the sculptor. "Works of sculpture," he says, "will have relief only to the extent that they are shaded, light in one part and dark in another. . . If we darkened all the light portions of a sculptured figure with paint until its tone was completely unified, the figure would appear devoid of relief altogether."

This contention substantially agrees with a statement by another defender of painting, Leonardo da Vinci; but it differs from it in one important respect: in maintaining that a statue exposed to a perfectly diffused light would look flat, Leonardo describes what happens under given natural conditions. Galileo, proposing to paint a statue dark wherever it is light, describes what human interference can cause to happen by determining the natural conditions. Leonardo invokes an experience that may or may not recur; Galileo suggests an experiment that can be repeated *ad libitum*. I have, in fact, repeated it in simplified form: I have photographed two reddish rubber balls, placed per-

[1] Eleven years later, Cigoli's painted portrayal of Galileo's moon was matched by the poetic description in Giovanni Battista Marino's *Adone*, X, 34–44, which culminates in the well-known tribute to Galileo and his telescopic discoveries, including the Jupiter satellites (for another example, see Tommaso Campailla. *l'Adamo, ovvero il Mondo creato* [Rome, 1637], III, 1–99). Conversely, the telescope was ridiculed or downright discredited by other poets and poetasters (see H. G. Dick, "The Telescope and the Comic Imagination," *Modern Language Notes*, 1943, *58*: 544 ff.), especially in the illustrated emblem books which tend to be neglected by historians of literature. Johannes de Brunes in *Emblemata of Zinne-werck* (Amsterdam, 1624, p. 333), for instance, likens the magnifying effect of the telescope to that of jealousy, envy and hatred, while Paolo Moccio in *Emblemata* (Bologna, 1628, p. 17) compares it to that of boastfulness. Silvestro Pietrasanta in *Symbola Heroica*, Amsterdam, 1634 (in the second edition of 1682, p. 23), brazenly asserts, under the heading *Non ideo maculor*, that the flaws in the character of a magnanimous prince are no more real than the sunspots which, according to Pietrasanta, are mere illusions caused by the vibration of the "opticum specillum."

pendicularly above each other, under identical lighting conditions before and after one of them had been treated according to Galileo's prescription. The left-hand photograph shows the two balls as real spheres; the other makes the upper ball, the lighted area of which had been darkened by paint, appear like a flat, black disk (Fig. 4).

Galileo thus reduces the claims of sculpture to one undeniable fact: its products are more closely akin to natural things in that they share with them the quality of three-dimensionality. But does this fact redound to the credit of sculpture? On the contrary, says Galileo, it greatly diminishes its merit because — and this is a most remarkable statement of principle — "the farther removed the means of imitation are from the thing to be imitated, the more admirable the imitation will be . . . . Will we not admire a musician who moves us to sympathy with a lover by representing his sorrows and passions in song much more than if he were to do it by sobs? And would we not admire him even more if he were to perform silently, on an instrument only, and achieve his aims solely by dissonances and passionate musical accents?"

Once musical theory had turned humanistic, it was agreed that the purpose of music was not only to delight the ear of the listener but also to influence his soul emotionally, intellectually and morally. There was a certain amount of dissension as to the relative importance of these aims, but no one doubted that music lived in an indissoluble union with poetry. Even Mersenne, who held that the essential value of music was perceptual rather than either moral or intellectual, conceived of it as illustrative of words, to which it gave *leur vrai sens*. And Galileo's own father had asserted that the text was "the most important thing in musical composition." He must have turned in his grave when his great son anticipated what Jacob Burckhardt was to say some two hundred and fifty years later: "Music, if we wish to penetrate the essence of its being, must be taken as instrumental music detached from words."

2

In Galileo's view, then, art is at its best where its "means of imitation" (sounds in the case of music; light, line and color in the case of the representational arts) are most emphatically distinct from its subject matter: the world of psychological experience, on the one hand; the world of three-dimensional things, on the other. And this insistence upon a clear and clean separation of values and procedures which at the time were commonly accepted as inseparable bears witness to a critical purism that may be said to be the very signature of Galileo's genius. As he preferred "pure," instrumental music to song, let alone to song intermixed with sobs or laughter, so did he insist on a separation of quantity from qualities, of science from religion, magic, mysticism and art. His discovery of the four Jupiter satellites was greeted with cries of horror by those who claimed that God would never have permitted the elements of the planetary system to exceed the sacred number of seven, and with cries of triumph by those who felt that Galileo's discovery had showed forth once more the metaphysical importance of the number four. Galileo himself would have

accepted any number without even thinking of its Biblical or Neo-Pythagorean implications: he objected to whatever amounted to a blurring of borderlines.

He loved the poets and historiographers but refused to accept them as authorities on questions of physics (ironically, even when they happened to be right).[1a] He was by no means averse to honest, straightforward indecency, but he resented it when out of place (particularly when the *faux pas* was committed unintentionally), and he squirmed at innuendo. In instinctive agreement with Samuel Butler's immortal phrase, "I don't mind lying, but I hate inaccuracy," he had no objection to Ariosto's fairies, dragons, hippogriffs and sorcerers but was annoyed when Tasso asked him to believe in a garden located in the middle of a palace yet containing, "hills, valleys, woods, caves, rivers, and swamps, and all this junk on top of a high mountain." And his main objection to the *Gerusalemme Liberata* was that it was allegorical. In his opinion allegorical poems, forcing the reader to interpret everything as a reference to something else, resembled those perspective trick pictures, known as "anamorphoses," which, to use Galileo's own words, "show a human figure when looked at sideways but, when observed frontally (as we naturally and normally do), display nothing but a welter of lines, colors, and strange, chimerical shapes." In similar manner, he thought, allegorical poetry "compels the straightforward narrative to adapt itself to an allegorical meaning, seen obliquely, as it were, and thus obstructs it by fantastic and superfluous figments."

The best-known example of such "perspectives which, rightly gazed upon,/ show nothing but confusion, viewed awry,/ distinguish form," is found in Holbein's *Ambassadors* in the National Gallery at London (Fig. 3), where the foreground is occupied by an object that certainly deserves to be called "a strange, chimerical shape"; it is only when viewed sideways from the extreme lower left that this object reveals itself as a death's-head — here serving both as a *memento mori*, an idea frequently expressed in portraits of the time, and as a hidden signature: the name Holbein means, translated literally, "hollow bone" (Fig. 5).

Elsewhere Galileo compares the procedure of those opponents who piece their arguments together from assorted quotations from Aristotle instead of "looking at the great book of nature" [1b] to another form of artistic trickery

[1a] My attention has been called to Galileo's approving reference to Ariosto (*Orlando furioso*, XVII, 30) in the *Due nuove scienze* (Ed. Naz., VIII, p. 169). Here Galileo explains that the bones in a creature larger than those existing in nature would have to be either disproportionately thickened or would have to consist of a different substance in order to fulfill the same function and concludes that Ariosto *may* have had this in mind (*forse*) when he described a giant in the following terms:

"Non si può compartir quanto sia lungo
Si smisuratamente è tutto grosso."

In the opinion of this writer Galileo here credits his favorite poet with more physical insight than he possessed: what Ariosto means to say is that, if the *width* of the giant (*grosso*, incorrectly translated by "size" in *Two New Sciences*, H. Crew and A. de Salvio, tr., New York, 1914, p. 131), which should be comparatively easy to estimate because he stands on the same level as does the beholder, is "beyond measure," the giant's *height*, extending far beyond eye level, is quite impossible to calculate. But even if Galileo's interpretation were correct, he would not have adduced Ariosto as an authority for a statement about physics (as did those who attempted to prove a scientific theory by examples taken from classical literature) but, on the contrary, would have paid a graceful compliment to his *accortissimo poeta* by crediting him with a quasi-prophetic insight into what he, Galileo, had discovered more than a hundred years later.

[1b] For the long history of the "book of nature" simile, see E. R. Curtius, *Europäische Literatur und lateinisches Mittelalter* (Bern, 1948), p. 323 ff. As a matter of curiosity there may be added the introduction to Ramon de

which had been greatly admired by earlier patrons and critics but which in his opinion could be justified only as a joke: the construction of faces or figures from assorted objects appropriate to the theme but constituting, as it were, a series of secondary images within the primary one. In this case we can even identify the particular target of Galileo's mockery: in citing, specifically, a personification of agriculture "entirely composed of agricultural implements" and personifications of the seasons "entirely composed of fruits or flowers" (Fig. 6), he evidently aims at an artist named Giuseppe Arcimboldo (died 1593) whose works, in part preserved, were widely imitated and eulogized in prose and poetry during his lifetime and even brought him a knighthood.[2]

3

Both perspective "anamorphoses" and what may be called "double images" are playful but characteristic manifestations of a peculiar style which we have learned to refer to as Mannerism. In Heinrich Wölfflin's *Principles of Art Theory* an attempt has been made to construe the style of the seventeenth century — the century that saw the emergence of both the florid Baroque of Bernini and the severe classicism of Sacchi or Poussin — as a diametrical contrast to the "classic" High Renaissance as represented by Leonardo da Vinci, Raphael, or Titian. But this construction was made possible only by the omission of everything that had occurred in between. In reality there had arisen, from as early as 1515–1520, an "anti-classic" tendency which had opposed to the ideals of rationality, selective verisimilitude, simplicity, and bal-

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Sabunde (Raymundus Sebundius, Raymond Sebonde), *Theologia naturalis sive liber creaturarum*. Here the author (died 1436 as professor at the University of Toulouse) says that God had given us two books, "the book of nature and the Bible," and that he, Sebundius, proposed to confine himself to the former. The *Theologia naturalis* was placed on the Index when Galileo was a youth of seventeen.

[2] The inclusion of this interesting passage, inadvertently omitted from the original pamphlet, was suggested by Mr. Stillman Drake. Found in the *Third Letter on the Sunspots* (*Le Opere di Galileo Galilei*, Edizione Nazionale, V, Florence, p. 190 f.), it reads as follows: "Restano solamente in contradizzione alcuni severi difensori di ogni minuzia peripatetica, li quali, per quel che io posso comprendere, educati e nutriti sin dalla prima infanzia de i lor studii in questa opinione, che il filosofare non sia nè possa esser altro che un far gran pratica sopra i testi di Aristotele, sì che prontamente ed in gran numero si possino da diversi luoghi raccòrre ed accozzare per le prove di qualunque proposto problema, non vogliono mai sollevar gli occhi da quelle carte, quasi che questo gran libro del mondo non fosse scritto dalla natura per esser letto da altri che da Aristotle, e che gli occhi suoi avessero a vedere per tutta la sua posterità. Questi, che si sottopongono a così strette leggi, mi fanno sovvenire di certi obblighi a i quali tal volta *per ischerzo si astringono capricciosi pittori*, di voler rappresentare un volto umano o altra figura con l'accozzamento ora de' soli *strumenti dell'agricoltura*, ora de' *frutti solamente o de i fiori di questa o di quella stagione*: le quali *bizzarrie, sin che vengono proposte per ischerzo*, son belle e piacevoli, e mostrano maggior perspicacità in questo artefice che in quello, secondo che egli averà saputo più acconciamente elegger ed applicar questa cosa o quella alla parte imitata; ma se alcuno, per aver forse consumati tutti i suoi studii in simil foggia di dipignere, volesse poi universalmente concludere, ogni altra maniera d'imitare esser imperfetta e biasimevole, certo che 'l Cigoli e gli altri pittori illustri si riderebbono di lui" (italics mine). That Galileo had Arcimboldo in mind is evident from the fact that one of the latter's most eloquent admirers, Giovanni Paolo Lomazzo, mentions precisely the same paintings (a personification of agriculture and a series of pictures representing the seasons) as does Galileo: *Trattato della pittura* (Milan, 1584), VI, 26, p. 349 f.; *Idea del tempio della pittura* (Milan, 1590), XXXVIII, p. 154 ff. For further references, see Thieme-Becker, *Allgemeines Lexikon der bildenden Künstler*, II, p. 70, and F. C. Legrand and F. Sluys, "Some Little-Known Arcimboldeschi," *Burlington Magazine*, 1954, 96: 210 f.

ance, a taste for the irrational, the fanciful, the complex, and the dissonant. The style of the seventeenth century resulted from two countermovements against this "anti-classic" or Mannerist style (both setting in toward the end of the sixteenth century) which, for all their diversity, were united in their desire to recapture the values of the High Renaissance: the revolutionary naturalism of Caravaggio and the reformatory eclecticism of the Carracci brothers and Domenichino — the former supported, as is so often the case, by sophisticated aristocrats as well as "long-haired radicals," the latter hailed by the *honnêtes hommes* whose views, equally averse to the "crude," or non-selective, imitation of nature and to the vagaries of Mannerism, found their expression in the theory of the *beau idéal*, the central dogma of the academies.

When we compare, for example, Raphael's *Madonna di Foligno* of 1511–1512 (Fig. 7) with a Madonna by Annibale Carracci, produced some eighty or ninety years later (Fig. 8), we perceive, all differences in style and temper notwithstanding, a basic community of intention. Carracci's figures, though painted in a looser, more pictorial manner and animated by a more intense emotion, do not appreciably deviate from what Raphael would have considered as the norm of nature. There is a tendency to harmonize the relationship between surface and depth, plastic volume and ambient space, pattern and intervals. And the Mother of God appearing to, and venerated by, saints, is easily accessible to the beholder's eye and mind.

A Mannerist painting such as Vasari's *Immaculate Conception* of 1540 (Fig. 9) differs from both Raphael's High Renaissance and Annibale Carracci's Proto-Baroque. The arbitrary proportions and contorted movements reveal inhibitions and tensions equally far from tranquility and open passion. The forms, strongly modeled but confined by tight contours, are crammed into a dense pattern which prohibits a reconciliation of volume and space. And the subject is an intricate allegory, perplexing, as we learn from his own words, to the artist himself and reduced to visible form only with the help of many erudite friends.

4

Galileo, born in 1564, was an eye witness to the revolt against this Mannerism, and it is not difficult to guess where he stood. He was, if not a friend, at least a well-disposed acquaintance of the very father of the theory of the *beau idéal*, Monsignor Giovanni Battista Agucchi. His *fidus Achates*, Lodovico Cigoli, played exactly the same role in Florence as did the Carracci brothers and Domenichino in Rome. And if Cigoli turned to Galileo as an authority in matters of artistic theory, Galileo cited Cigoli as an authority in matters of artistic taste — as when he says that Cigoli, "like any other first-rate painter," would laugh at those who might consider double images *à la* Arcimboldo as serious or even exemplary works of art.[3]

[3] For the success of Arcimboldo (court painter to three successive German emperors, Ferdinand II, Maximilian II and Rudolph II) and the praise lavished upon him by critics and poets writing two or three decades before Galileo, see particularly Lomazzo as cited in the preceding note. In his *Trattato* this author prints a poem by Gregorio Comanini (cf. also

FIG. 1. Ludovico Cigoli, The Assunta (fresco). Rome, Santa Maria Maggiore.

FIG. 2. Florence, Biblioteca Nazionale, MSS. Gal., Par. III, T.III (Draft of Galileo's *Sidereus Nuncius*), fols. 8 ff. Crescent moon, drawing (turned by 90 degrees).

FIG. 3. Hans Holbein the Younger. The Ambassadors. London, National Gallery.

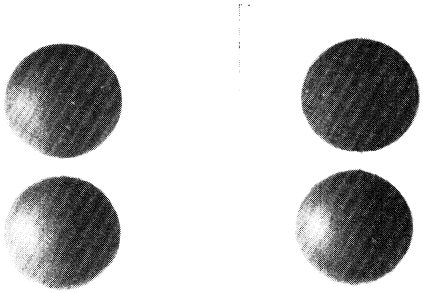

FIG. 4. Illustration of Galileo's discussion of "visible" and "tangible" relief.

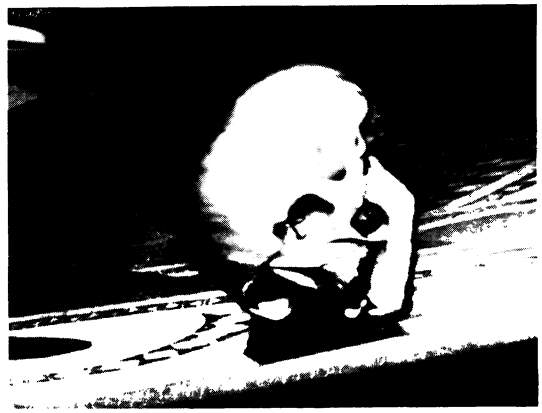

FIG. 5. Detail of Fig. 3. Rectification of the "anamorphosized" skull in the foreground.

FIG. 6. Giuseppe Arcimboldo. Summer. Vienna, Kunsthistorisches Museum.

FIG. 7. Raphael. Madonna di Foligno. Rome. Pinacoteca Vaticana.

FIG. 8. Annibale Carracci, Madonna and Saints. Bologna, Pinacoteca.

FIG. 9. Giorgio Vasari. Immaculate Conception. Florence. SS. Apostoli.

FIG. 10. Giovanni Paolo Pannini, "Classical Rome." New York, Metropolitan Museum.

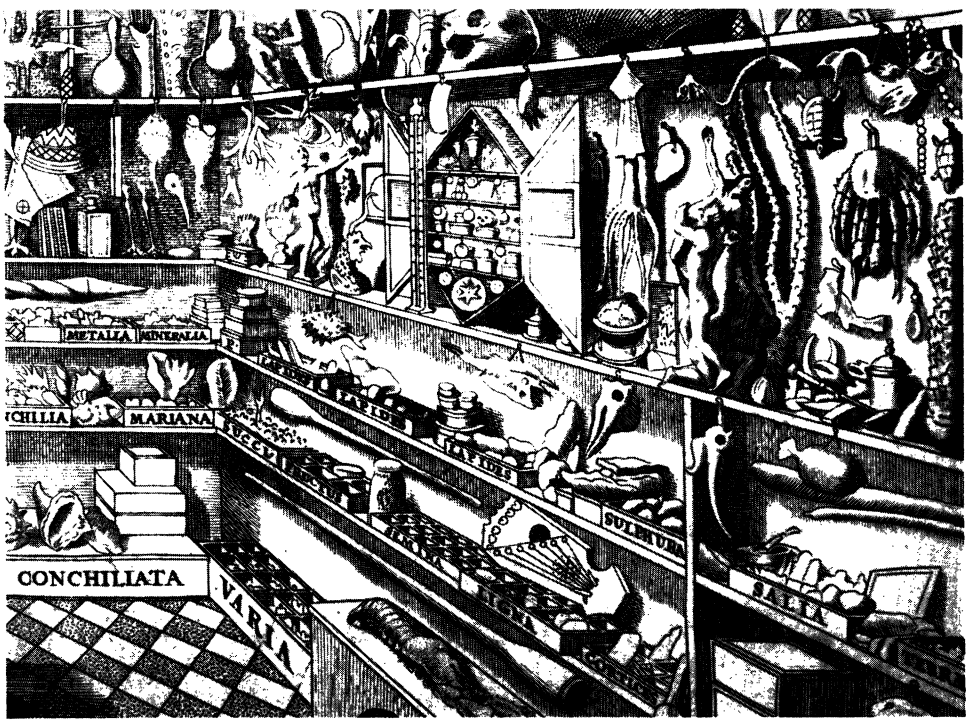

FIG. 11. G. Wingendorp, Title Page of *Museum Wormianum, seu Historia Rariorum, tam naturalium, quam Artificialium, tam Domesticarum quam Exoticarum, quae Hafnia Danorum in aedibus Authoris servantur*, Leiden, 1655 (detail including a small replica of Giovanni da Bologna's Rape of the Sabine Women).

FIG. 12. Correggio. Madonna of St. Francis. Dresden, Gemäldegalerie (detail).

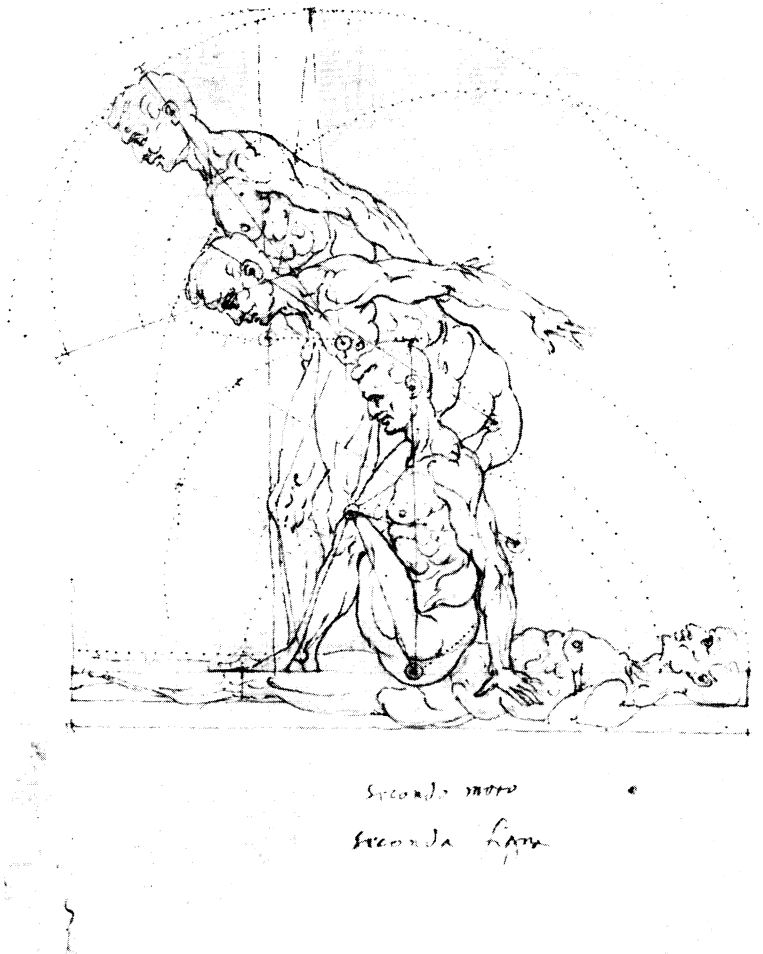

FIG. 13. New York, Pierpont Morgan Library, MS. M.A.1139 ("Co
Huygens"), fol. 22. Analysis of human movement according to the princi
of Leonardo da Vinci.

Galileo's aesthetic judgments — whether of music, painting or poetry — thus appear to be dictated by a consistent principle or, if you will, by an insurmountable prejudice: a classicistic prejudice in favor of simplicity, order, and *séparation des genres*, and against complexity, imbalance, and all kinds of conflation. And that this unity of principle was felt by Galileo himself is evident from the fact that some of his strongest objections to his pet aversion, Tasso, are clothed in similes borrowed from the visual arts. That he compared Tasso's allegorical method to perspective anamorphosis has already been mentioned. And right at the beginning of his discussion he describes the contrast between Tasso's and Ariosto's styles in terms which, without much verbal change, might be applied to the two paintings by Raphael and Vasari which we have just considered; or, for that matter, to any High Renaissance picture as compared to any work of any Mannerist such as Bronzino or Francesco Salviati, who was the favorite painter of Tasso: "Tasso's narrative resembles a piece of marquetry rather than an oil painting, for marquetry uses little varicolored pieces of wood which never unite very smoothly, so that the contours remain sharp and precise and the figures strike us as dry, hard and without roundness. In an oil painting, however, the contours are softly dissolved, and by virtue of smooth transitions from one color to the other the picture becomes soft, round and rich in relief. Ariosto shades and models in the round . . . . Tasso works piecemeal, dryly and sharply, filling his stanzas, for want of words, with concepts having no cogent connection with what is said or to be said."

In an even more amazing passage, perhaps fully appreciable only by art historians, Galileo draws another parallel: "When setting foot into the *Orlando Furioso*, I behold opening up before me a treasure room, a festive hall, a regal gallery adorned with a hundred classical statues, with countless complete historical pictures by the most excellent masters and full of everything that is admirable and perfect." One thinks of both the *School of Athens* and the rich gallery pictures by Giovanni Paolo Pannini (Fig. 10). When reading the *Gerusalemme Liberata*, however, it seems to Galileo that he enters "the study of some little man with a taste for curios who has been pleased to fit it out with things that have something strange about them because of age or rarity or for some other reason but are, as a matter of fact, nothing but bric-a-brac: a petrified crayfish, a dried-up chameleon, a fly and a spider embedded in a piece of amber; some of those little clay figures which are said to be found in the

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the latter's *Il Figino*, Mantua, 1591) which glorifies a *Flora* entirely composed of flowers and is so characteristic of the amphigoric and amphibolic — as Galileo would say, "oblique" — mentality expressing itself in double images of this kind that it deserves to be quoted in full:

"Son'io Flora ò pur Fiori?
Se Fior', come di Flora
Hò co'l sembiante il riso? e s'io son Flora,
Come Flora è sol Fiori?
Ah non Fiori son io; non son'io Flora.
Anzi son Flora, e Fiori,
Fior mille, & una Flora,
Viui Fior, viua Flora,
Perch'i Fiori fan Flora, e Flora i Fiori.
Sai come? I Fiori in Flora
Cangiò saggio Pittore, Flora in Fiori."

"Am I Flora or just flowers? If [I am] flowers, how does it happen that my face bears the smile of Flora? And if [I am] Flora, how [does it happen] that Flora is nothing but flowers? I am neither flowers nor Flora; yet I am Flora as well as flowers — a thousand flowers and one Flora, living flowers and a living Flora — because the flowers make [the image of] Flora, and [the goddess] Flora makes the flowers. Do you know how? The ingenious painter has transmuted flowers into Flora, Flora into flowers."

ancient tombs of Egypt; and, as far as painting is concerned, some little sketches by Baccio Bandinelli or Parmigianino."

Here Galileo portrays to a nicety and with evident gusto one of those jumbled *Kunst- und Wunderkammern* so typical of the Mannerist age (Fig. 11). And when he contrasts "the countless complete historical pictures by the most excellent masters" with "some little sketches by Bandinelli and Parmigianino," he not only disparages the small and trifling in favor of the large and lofty, and the fragmentary and preliminary in favor of the finished and final, but also points his finger with unerring accuracy at two Cinquecento artists whose names are still synonymous with Mannerism *pur sang*.

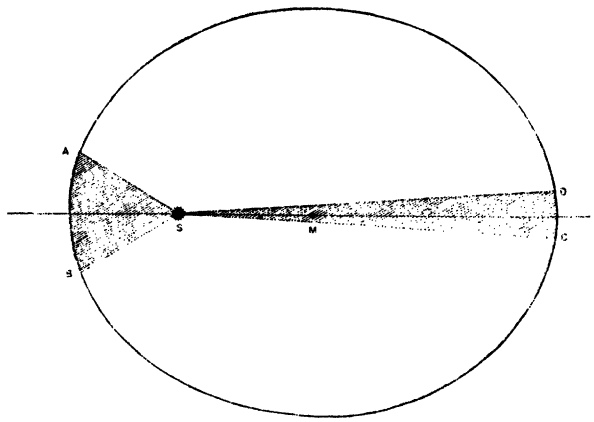
Tasso has never lost his place among the great poets of the human race, and our own twentieth century has thoroughly revised the wholesale condemnation of Mannerism as an art form. Arcimboldo's double images are having a vogue in the circles of the Museum of Modern Art in New York. Some of us would rather have a nice *Kunst- und Wunderkammer* full of ushabtis, petrified crayfish and Parmigianinos than a formal gallery full of Roman marbles and Raphaels. And many are those in whom a prolonged diet of stainless steel and plate glass has produced an appetite for such less hygienic fare as the Palazzo Spada or the Casino of Pius IV. But if Galileo thought as he did and wrestled with the spirit of Tasso, even as Luther wrestled with the devil, up to his dying day, his attitude commands respectful attention. We cannot explain the *Considerazioni al Tasso* as a product of historical conditions, for many honorable men held opposite views in Galileo's own period. Nor can we dismiss it as a "youthful error inspired by the rampant rationalism of a naïvely one-sided scientific attitude." In fact, a case may be made, if not for reversing this extraordinary pronouncement of an enraged Tasso scholar, at least for recasting it into a statement of complementarity. If Galileo's scientific attitude is held to have influenced his aesthetic judgment, might not his aesthetic attitude have influenced his scientific theories? Or, to be more precise, might he not have obeyed, both as a scientist and as a critic of the arts, the same controlling tendencies?

5

It is a well-known but puzzling fact that Galileo always ignored the Keplerian laws (Text Ill. 1) although the first and second of them were demonstrably known to him from 1612 at the latest.[4] To assume that Galileo presented the Copernican system in its original form (circular rather than elliptical orbits and uniform motion rather than periodic acceleration and deceleration) in order to make it more easily digestible to the general reader *might* explain Galileo's omission of Kepler's laws from his *Dialogue*; but it would not explain

[4] Galileo's early familiarity with Kepler's first and second laws is unequivocally proved by a letter addressed to him by Federico Cesi on 21 July 1612 (Galileo, Ed. Naz., XI, p. 365 f.). Not mentioned by Olschki, Strauss, Wohlwill, etc., this letter has been adduced in this connection in *Galileo as a Critic of the Arts*, p. 25. Mr. Stillman Drake has, however, been kind enough to point out to this writer *in litteris* that its importance had already been stressed, precisely forty years ago, by Antonio Favaro, "Avversaria Galileana, I," *Atti e Memorie della R. Accademia di Scienze, Lettere et Arti in Padova*, new ser., 1916, *32*: 123 ff., particularly p. 131 f.

their elimination from his whole thinking.[5] He seems to have dismissed them from his mind — in an act of automatic self-defense, as it were — as something incompatible with the very principles which dominated his thoughts as well as his imagination.[6]



TEXT ILL. 1. Schematic Illustration of Kepler's First and Second Laws.

Everyone knows the famous passage at the very beginning of the *Dialogue* where Galileo endorses the belief, common to Platonists and Aristotelians, in the perfection of the circle not only from a mathematical and aesthetic but also from a mechanical point of view: according to him the qualities of uniformity and perpetuity, reserved to rectilinear motion in post-Galilean dynamics, exclusively belong to the circular movement which Huygens and his successors have taught us to consider as vectorially accelerated. "Circular motion is naturally [that is, without external interference] appropriate to the bodies constituting the universe and disposed in the best order; rectilinear motion has been assigned by nature to the bodies and their parts only where they are disposed in bad order, outside their proper places."

Everyone also knows that Galileo, when discussing the absolute motion of free-falling bodies *in hypothesi terrae motae*, erroneously describes their trajectory as a perfect semicircle connecting the point of departure with the center of the earth.[7] But few Galileists have found it in their hearts to take such pronouncements at their face value, all the more so as the triumphant conclusion of Galileo's discussion of absolute motion is couched in language that

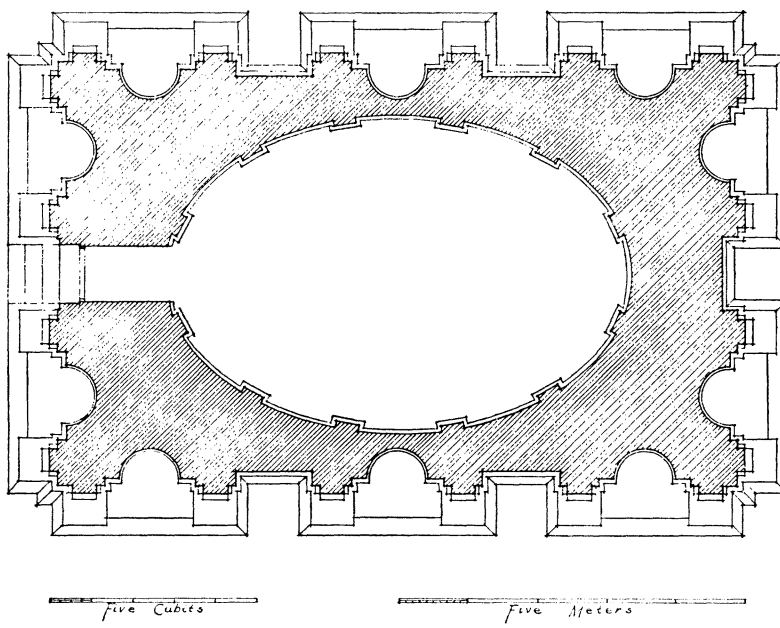
[5] See Koyré, "Attitude esthétique . . . ," p. 841 f.

[6] A similar view has been expressed by G. de Santillana, *The Crime of Galileo*, Chicago, *n.d.* [1955], p. 106, Note 29: "Galileo seems to have heard from someone (Cesi or Cavallieri) a casual mention of the elliptical orbits, but it must have set in motion a protective mechanism in his own mind, for his theory needed circles as a physical reality." Cesi is also mentioned, though again without special reference to the letter of 1612, in the same author's excellent edition of Galileo's *Great World Systems in the Salusbury Translation*, Chicago, 1953, p. 349, note 34.

[7] For Galileo's treatment of this problem, see A. Koyré, "An Unpublished Letter of Robert Hooke to Isaac Newton," *Isis*, 1952, *43*: 312 ff.; *idem*, "A Documentary History of the Problem of Fall from Kepler to Newton; *De motu gravium naturaliter cadentium in hypothesi terrae motae*," *Transactions of the American Philosophical Society*, new ser., 1955, *45*: 2.

sounds as metaphysical or even aesthetic as that of the introductory passages.

We may well ask, however, whether such passages should not be taken seriously not in spite but because of the fact that they sound metaphysical or even aesthetic: whether their *style soutenu* might not express the very depth of a conviction — that of the purist and the classicist — which, on the one hand, dictated Galileo's mortal aversion to "impure" music, allegorical poetry, perspective anamorphosis and double images and, on the other, produced that *hantise de la circularité* (to borrow the beautiful phrase of Alexandre Koyré) which made it impossible for him to visualize the solar system as a combination of ellipses. Where we would consider the circle as a special case of the ellipse, Galileo could not but feel that the ellipse is a distorted circle: a form which was, so to speak, unworthy of celestial bodies; which cannot result from what he conceived as uniform motion; and which, we may add, was as emphatically rejected by High Renaissance art as it was cherished in Mannerism. In painting it does not occur until Correggio (Fig. 12); in sculpture, not until Gian Maria Falconetto,[8] Pierino da Vinci and Guglielmo della Porta; in architecture



TEXT ILL. 2. Michelangelo, First Project of the Tomb of Julius II, Ground Plan (reconstruction).

[8] For elliptical ground plans in Renaissance architecture and architectural theory, see W. Lotz, "Die ovalen Kirchenräume des Cinquecento," *Römisches Jahrbuch für Kunstgeschichte*, 1955, 7: 9 ff. It is the author of this most interesting monograph who called the writer's attention to the elliptical frames in Falconetto's Casino Cornaro et Padua of *ca.* 1525 (A. Venturi, *Storia dell'arte italiana*, XI. 1, Figs. 8, 9; for the artist, see Thieme-Becker, *op. cit.*, XI, p. 223 f.).

— apart from Michelangelo's first project for the tomb of Julius II (Text Ill. 2), where it creeps in, as it were, as an interior feature invisible from without — not until Baldassare Peruzzi.

Kepler, on the other hand, did break the "spell of circularity" not only in establishing the elliptical shape of the planetary orbits but in a much more general way. In contrast to Galileo — though not as yet in the sense of post-Galilean physics [9] — he considered the rectilinear and not the circular movement as "natural" to the physical world: "I deny," he says, "that God has instituted any perpetual nonrectilinear motion unguided by mental control." And the contrast between his and Galileo's point of view becomes almost amusingly evident when both attempt to support their celestial mechanics by drawing a parallel between the movements of the stars and those of the human body. Kepler assures us that "all muscles operate according to the principle of rectilinear movement": "the bending of the head, the feet and the tongue are brought about by straight muscles shifted and stretched from here to there." Galileo, thinking in terms of effect (positional change) rather than cause (muscular action), comes to exactly the opposite conclusion. "All human or animal movements," he contends, "are circular; and to the objection that man can run, jump, walk up and down, etc., he replies: "Yes, but these are only secondary movements depending on the primary ones which take place at the joints. It is from the bending of the leg at the knee and of the thigh at the hip, which are circular movements, that the jump or the run results."

Galileo, then, reduces all human movements to a system of circles and epicycles; and this is, curiously enough, precisely what Leonardo da Vinci had suggested in his *Trattato della pittura* and systematically elaborated in a treatise on human movement which can be reconstructed from the compilation of one of his followers (Fig. 13). Galileo could hardly have known of Leonardo's ideas; but it is noteworthy that his conception of human movement as completely agrees with that of the first High Renaissance painter as it differs from that of the greatest contemporary astronomer. In fact, this difference evinces, beyond the question of circularity and rectilinearity, a basic contrast between a cinematic and a dynamic interpretation of movement as such — a contrast which, as Alexandre Koyré has pointed out, applies to Galileo's and Kepler's astronomical as well as to their anatomical notions.[10]

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Shall we conclude from all this that Kepler was more "modern" than Galileo? Nothing could be farther from the truth. If Kepler was more nearly right in several cases,[11] it was not because he had fewer prejudices but because his

[9] The statement in *Galileo as a Critic of the Arts*, p. 26, line 3, was proved to be incorrect by Koyré, "Attitude esthétique . . . ," p. 844.

[10] Koyré, *ibidem*.

[11] For Kepler's view on the problem of the absolute motion of free-falling bodies, see Koyré, "A Documentary History. . . ."

prejudices were of a different kind. And it is one of the most amazing paradoxes in history that Galileo was in error in some respects precisely because he was more "progressive" than Kepler in principle.

Kepler and his friends were, after all, no less deeply committed to the belief in the metaphysical supremacy — as we would say, the "privileged status" — of the circle and the sphere than Galileo. He was, in fact, the stricter Platonist (or Aristotelian) in that he accepted the ontological difference between geometrical figures and physical bodies which Galileo dared to deny. Galileo had learned to consider the ideas of *the* sphere or *the* circle as adequately realized in every material sphere or circle; Kepler still sharply distinguished between "the intelligible idea of the circle" and the "actual path of a planet." But just this "modern" geometrization of nature — or, put it the other way, materialization of geometry — made it difficult for Galileo to deny the privileged status of circularity in physics and astronomy while accepting it as axiomatic in mathematics and aesthetics; whereas, conversely, Kepler's "conservative" separation between ideal and material form enabled him to affirm that even the celestial bodies, *qua* bodies, were bound to deviate from a perfectly circular course, however desirable from a metaphysical point of view, when such a deviation was required by the laws of nature: "If the celestial movements," he says, "were the work of the mind, it could be validly concluded that the orbits of the planets are perfect circles . . . ; the celestial movements, however, are not the work of the mind but the work of nature, that is to say, of the natural faculty of bodies or of a soul that acts in full accord with these corporeal faculties . . . ; even assuming that we were to endow the planets with intelligences, these intelligences would still be unable to achieve what they want, that is to say, the absolute perfection of the circle; for . . . since, in order to produce movement, there would also be necessary, in addition to the mind, the natural and animal faculties, these would follow their own inclinations [*ingenium*]; they would not do everything according to the dictates of the mind — which they would not apprehend — but would do much according to natural necessity."

Here Kepler explicitly rejects a mathematical and aesthetic prejudice which Galileo implicitly accepts; but he rejects it — as is evident from the very wording of the text just quoted — in the name of a still animistic cosmology which in Galileo's mind had never existed, and whose intrusion upon "pure science" must have struck him as no less outmoded, illegitimate and, if one may say so, Manneristic,[12] than Tasso's allegorical poetry, perspective anamorphosis and the "double images" of Arcimboldo (court painter, incidentally, to Kepler's imperial patron, Rudolph II). If — to quote Alexandre Koyré once more — Kepler succeeded in substituting celestial dynamics for celestial cinematics, he was able to do so precisely because he had never given up the

[12] See Koyré. "Attitude esthétique . . . ," pp. 843, 846.

[13] See Koyré, *ibidem*, p. 847.

traditional Aristotelian interpretation of motion as a "process" (according to him the planets would stop in their tracks if the *species motrix* or *virtus motoria* supposed to emanate from the sun ceased to act upon them), while Galileo had progressed to the interpretation of motion as a "state": [13] as Galileo ignored — and, in a sense, was bound to ignore — Kepler's ellipses, so did Kepler ignore — and, in a sense, was bound to ignore — the principle of inertia quite clearly (though restrictedly) stated in Galileo's *Second Letter on the Sunspots* of 1612.[14]

[14] Galileo, Ed. Naz., V, p. 134 f.: "Imperò che mi par di osservare che i corpi naturali abbino naturale inclinazione a qualche moto, come i gravi al basso, il qual movimento vien da loro per intrinseco principio e senza bisogno di particolar motore esterno . . . e però, rimossi tutti gl'impedimenti esterni, un grave nella superficie sferica e concentrica alla Terra sarà indifferente alla quiete ed a i movimenti verso qualunque parte dell'orizonte, ed in quello stato si conserverà nel qual una volta sarà stato posto; cioè se sarà messo in stato di quiete, quello conserverà, e se sarà posto in movimento, v.g. verso occidente, nell'istesso si manterrà: e così una nave, per essempio, avendo una sol volta ricevuto qualche impeto per il mar tranquillo, si moverebbe continuamente intorno al nostro globo senza cessar mai, e postavi con quiete, perpetuamente quieterebbe, se nel primo caso si potessero rimuovere tutti gl'impedimenti estrinseci, e nel secondo qualche causa motrice esterna non gli sopraggiugnesse." The fact that Kepler ignored Galileo's restricted principle of inertia just as Galileo ignored Kepler's first and second planetary laws was brought to the writer's attention by Mr. Stillman Drake.