# Aristotle, Copernicus, Galileo

*by Pierre Conway, O.P.*

BY DINT OF historical narrative created for the purpose, it has gradually come to be assumed that the twin revolts against the Catholic Church—the Renaissance and the Reformation—were somehow revolts in favor of reason. That the revolts did indeed occur is a matter of history. But that they were in favor of reason is a quite gratuitous conclusion. They were in reality revolts, not in favor of reason, but *against reason.*

Possibly the most evoked figure in this connection is Galileo Galilei of the Lincean Academy—whose most famous words, *E pur si muove,* he never uttered. Only recently he has been made the object of yet another article circulated by the millions,[1] destined to hallow him—in virtue of his conflict with ecclesiastical authorities—as a great apostle of enlightenment and the forerunner of what is assumed to be an age of reason.

Since such articles—unless they fail in their purpose—are calculated to leave the reader with the impression that the degree of enlightenment attained by the human race is more or less exactly proportional to the degree in which the human race recedes from the sphere of the Catholic Church, it will not be superfluous to reexamine the role of reason and the Catholic Church in the elaboration of the Copernican system upon which the popular fame of Galileo rests.

The heliocentric theory, with its twofold supposition of the earth's rotation upon its own axis, and of its motion around the sun, has been known in one form or another for several

[1] Donald Culross Peattie, "Galileo—Bold Discoverer," *The Reader's Digest,* June, 1948.

thousand years. Aristotle quotes the first supposition as being contained in Plato's *Timaeus*. The second is inherent in the Pythagorean doctrine that fire is in the center of the universe and that the earth revolves about the centre—likewise quoted by Aristotle.[2] The Pythagoreans, however, did not hold the sun to be the centre of the universe.[3] The first complete statement of the heliocentric system is due to Aristarchus of Samos, believed to have succeeded Theophrastus in 288 as the third head of the Peripatetic school founded by Aristotle. Archimedes, twenty-five years his junior, writes thus of Aristarchus: "His hypotheses are that the fixed stars and the sun remain unmoved, that the earth revolves about the sun in the circumference of a circle, the sun lying in the middle of the orbit."[4] St. Thomas Aquinas, commenting upon Aristotle in the 13th century, speaks of the possibility of such a system in contrast to the Ptolomaic theory, and mentions Aristarchus as one of its proponents.[5] In the 15th century, Nicholas of Cusa taught such a theory in his book, *De Docta Ignorantia*, written in 1440, printed in 1514.[6] In 1448 he was created Cardinal by Pope Eugenius IV.

[2] Aristotle, *On The Heavens*, 293b.

[3] Angus Armitage, *Copernicus, The Founder of Modern Astronomy* (London, 1938), p. 90. ". . . Certain Pythagoreans suggested that the Earth might possess a motion of translation, though their system was in no sense a heliocentric one."

[4] Sir Thomas Keith, *Aristarchus of Samos* (Oxford, 1913), p. 302.

[5] "That motion should appear, is caused either from the motion of that which is seen or from the motion of the one seeing. And therefore, some, presupposing that the stars and the whole heaven are at rest, suppose the earth on which we live to be moved from west to east around the equinoxial poles once a day; and thus through our own motion it seems to us that the stars move in a contrary direction, an opinion which is held to be that of Heraclitus of Pontus and Aristarchus." (St. Thomas Aquinas, *Commentaria in Libros Aristotelis de Caelo et Mundo*, ed. Leon., Rome, 1886, II, 1. xi, no. 2.)

[6] "Now it is clear to us that the Earth is really in motion, though this may not be apparent to us, since we do not perceive motion except by a certain comparison with something fixed." "Since then the Earth cannot be the centre (of the universe), it cannot be entirely devoid of motion."

In the beginning of the 16th century, Nicholas Copernicus, a canon and later administrator of the diocese of Varmia (Ermeland) in Poland, began to give the heliocentric theory a scientific form. He had come to know of it as a "Pythagorean" theory—although it was not actually such—in the course of his studies at the University of Bologna. In 1500 he taught mathematics in Rome. In 1512, because of his astronomical skill, he was consulted by the Lateran Council on the reform of the Julian Calendar. The difficulties involved in such a reform as based upon the traditional concepts of the motions of the sun and moon were one of the motivating forces which led him to elaborate the new system which has come to bear his name. Returning in 1503 to his diocese and official cares—including the defence of the city of Olsztyn against Albrecht Hohenzollern, Grand Master of the Teutonic Order, who by apostasizing in favor of Protestantism and secularizing the goods of the Order, founded the present-day state of Prussia—he continued his astronomical observations from the tower of the Cathedral of Frauenburg, centre of the diocese.

In 1533, a disciple of his and papal secretary, Johann Widmanstadt taught a first sketch of the Copernican theory, the *Commentariolus*, before Clement VII in Rome. The Pope was very favorably impressed and from that day forward pressure was brought to bear upon Copernicus to publish his theory in full. That pressure was exercised principally by two Catholic prelates, Cardinal Schönberg, the Dominican Bishop of Capua attached to the papal Curia, and Bishop Giese of Culm, Copernicus' lifelong friend—as the preface to the *De Revolutionibus* testifies.

The new era of reason had meanwhile dawned on October 31, 1517, the day on which Luther nailed his 95 theses to the door of the Wittenberg church. As the most distinguished repre-

(*De Docta Ignorantia*, II, ch. 11-12; cf. Angus Armitage, *op. cit.*, pp. 89, 90.)

sentatives of this dawning devotion to reason, Luther and Melancthon had also their word to say about Copernicus. When the subject of Copernicus and his theory came up at Luther's table on June 4, 1539, Luther had this to say:

> That's the way the world goes: whoever wants to be wise in such matters cannot be satisfied with anything which others do. He must make something of his own for himself; and that has to be the very best—the way he has done it. *The fool wants to turn the whole art of astronomy upside down.* Joshua ordered the sun to stand still, not the earth.[7]

The very fact that in his theory Copernicus appealed to reason was enough to render it suspect to Luther. The belief in his teaching, "the teaching which I did not receive from them (critical Scripture scholars of his own school), but rather through divine grace from God," must be protected by a determined warfare against reason, "the Devil's bride, the beautiful harlot," "for reason is the highest whore the Devil has." [8]

Melancthon, in a letter written in 1541 to Burcard Mithobius concerning the protestantizing of Pomerania and the liquidation of the monasteries, alludes, among his troubles, to the absurd fable put forth by "that Sarmatian (Polish) astronomer, who moves the earth and makes the sun stand still." Wise rulers should repress "this arrogance of minds." [9] Such freedom of thought was in no way pleasing to the founders of Protestantism who demanded that in all matters, whether of revelation or of reason, their own personal and arbitrary opinions be alone endowed with certainty.

Even when the *De Revolutionibus Orbium Coelestium* was finally brought to the publishers, the Reformers were not above a final act of sabotage. In keeping with Luther's principle that against the Papacy, the seat of Antichrist, "all things are per-

[7] *Werke* (Erlangen, 1826-1868), LXII, 319.
[8] *Op. cit.*, XX², 2, 479 ff.
[9] *Corpus Reformatorum* (Halle, 1834), Vol. IV, 679.

mitted," [10] Osiander, one of Luther's most eminent disciples—the same who converted Albrecht Hohenzollern to a convenient Protestantism—charged with supervising the printing in the absence of Johannes Rheticus, took advantage of his position to insert an anonymous preface calculated to nullify the whole effect of the work. A writer by no means partial to the Catholic Church, qualifies what he calls "Osiander's sacrilegious interpolated preface," as "one of the most disgusting and portentous literary scandals ever perpetrated." [11] Nevertheless this dishonest act affords a magnificent opportunity, by the juxtaposition of the preface of Osiander with that of Copernicus, to compare the attitudes of the Reformers on the one hand, and the Catholic Church, on the other, toward the heliocentric theory and rational science in general.

Osiander's preface, addressed "To the reader of the hypotheses of this work," is arrogantly set at the head of the book, before that of Copernicus.[12] In it, he not only sets out to discredit the hypotheses in question, but astronomy itself and with it all scientific knowledge—true to the Protestant principle that only that which is divinely revealed is true, and there is no revelation but to Luther.[13] Thus, after stating that it is the task of astronomers to collect the heavenly motions from observation, he goes on to qualify the validity of such knowledge: "Then (they should proceed) to the causes of the same, or rather the hypotheses, since it could never be that they should be true. . . ." It is evident from this that Osiander means—

[10] *Briefwechsel*, ed. L. Enders (Frankfurt a. Main, 1884-1907), II, 461.

[11] Hermann Kesten, *Copernicus and His World* (New York, 1945), p. 295.

[12] *Nicolai Copernici Torinensis De Revolutionibus orbium coelestium, Libri VI* (Nuremberg, 1543). (Reproduced in facsimile for M. J. Hermann, November, 1927.)

[13] "While Copernicus thought only of the truth, Osiander had to consider his position as leader of the Reformation in Franconia. In order not to imperil it he took into consideration Luther and Melancthon who had laughed at the 'astrologer in Poland.'" Hermann Kesten, *op. cit.*, p. 298.

in distinction to Copernicus who likewise uses the word—by *hypothesis* "that which cannot possibly be true."[14] He pursues:

> . . . It is not necessary that these hypothesis should be true, nor even verisimilar . . . , for who is so ignorant as to hold the epicycle of Venus for verisimilar. . . . And there are other things in this discipline which are no less absurd.

This art "absolutely and simply" ignores the causes of the apparent unequal movements. The astronomer merely takes the hypothesis which is the most easy to comprehend. "The philosopher might require a greater likeness of truth, but neither can comprehend or teach anything certain *unless it has been divinely revealed to him.*" Having thoroughly nullified the power of the human mind to arrive at truth through reason, Osiander, one of the first representatives of the new era of enlightenment, terminates his preface: "Let no one, as far as the hypotheses are concerned, expect anything true from Astronomy, since it seeks to set forth no such thing, lest by taking as true things cogitated for another use, he should leave this discipline more stupid than when he approached it."

Then follows the letter of Cardinal Schönberg, written to Copernicus from Rome in November, 1536, undoubtedly with the full approbation of Clement VII. The astronomer whom the enlightened founder of Protestantism calls "a fool," is addressed by the Roman Cardinal as "a most learned man." Expressing his esteem for Copernicus, Cardinal Schönberg then refers to "the new idea of the World you have constituted, . . . in which you teach that the Earth is moved, and the Sun is at the lowest part of the world and therefore holds the middle

[14] "Melancthon had written in his own textbook that astronomical theses could not claim to be true." (Hermann Kesten, *op. cit.*, p. 299.) Melancthon in his *Introduction to Physics*: "These jokes are not new. . . . It is unbecoming publicly to defend such absurd theses, and even harmful because it sets a bad example." *Ibid.*, p. 319.

place, . . . to the great admiration of all." He begs that "most learned man" to communicate his find to the learned, or at least to send him a copy of his manuscript, for which he will pay the expense.

Finally comes the magnificent dedication of Copernicus of his work to Pope Paul III. Although Copernicus died as his book was brought to him and never knew of the scurrilous act which Osiander had perpetrated against his express wish, his own dedication and preface is a powerful disavowal of that arbitrary rejection of reason in favor of personal judgment which, reigning in the heigh-day of Protestantism as "divine revelation," now reigns as "freedom of thought." Copernicus clearly states the function of the philosopher and scientist: to seek "the truth in all things as far as it is permitted by God to human reason." He, the Catholic, realizes that reason can arrive at truth, the Reformer—and ultimately the agnostic—will not admit it. Copernicus has withheld his findings thus far "not, as some think, from any inevidence of the doctrines to be communicated, but lest most beautiful things, investigated by much study of great men, should be contemned" by those either too lazy or too stupid to understand. (We have seen who were Copernicus' principal adversaries.) He goes on to say how his friends, Nicholas Schönberg, Cardinal of Capua, and Tiedemann Giese, Bishop of Culm—to whom he confided his manuscript for publication by Johannes Rheticus—had finally persuaded him after many years to give his complete work to the public so that "it [the public] might see the darkness of absurdity removed by most lucid demonstrations."

Copernicus realizes that his theory is "contrary to the received opinion of the Mathematicians and nearly against common sense." He has been motivated by the fact "that the Mathematicians do not agree in their seeking out of the heavenly motions." "I began to grow tired that no more certain explanation of the movements of the machine of the world,

which was made for us, by the best and most regular Workman of all, should have appeared to the philosophers." Thus he began to wonder "whether if motion were given to the earth," there would not be "more firm demonstrations." And so he presents his work "after much and long observation." He dedicates it to his Holiness so that he may with his authority and judgment repress with ease the "bites of calumniators," although he knows that it is proverbial that "there is no remedy against the bite of the sycophant." He makes short shrift of those who would oppose him from Scripture.

> If perchance there may be foolish talkers who—although ignorant of the whole of Mathematics, nevertheless presume to judge such things—because of some place in Scripture, wrongly twisted to their sense, dare to reprehend and attack my work, I waste no time on them, to the point that I even despise their judgment as temerary.

Copernicus then recalls how Lactantius, though learned in his own field, went astray when he proclaimed the earth was flat against those who knew better. "Mathematics are written for mathematicians, to whom, if I am not mistaken, my labors will appear to have contributed something to the ecclesiastical republic." Copernicus here specifically alludes to the difficulties in reforming the Church calendar, on which he had been consulted, because of uncertainty as to the measurements of the moon and sun.

In this preface, Copernicus, the Catholic, does not speak, as Osiander does, of "hypotheses . . . that can never be true," but of "demonstrations," real knowledge of a real order, attained by reason. He does not fear contradiction by the Scriptures because he knows that whatever may be shown consonant to reason cannot possibly be in contradiction to God, the author of reason. The Reformer, on the other hand, not only invalidates the power of reason to arrive at truth—the basis of modern agnosticism, but is perfectly prepared to accept a God who con-

tradicts reason—the basis of all the sects inspired by the Lutheran "emancipation."

As Copernicus predicted, the more exact computation of the motions of the moon and sun, rendered possible by the Copernican system, resulted in the Gregorian Calendar, which was substituted for the Julian in all *Catholic* countries on October 5, 1582, which thereby became October 15. The vernal equinox was thus returned from March 11—whither it had advanced in virtue of the over-calculation of the solar year—to March 21st. Despite the obvious *reasonableness* of this correction, immediately evident to such Protestant astronomers as Tycho Brahe and Kepler, "enlightened" Protestant leaders opposed its acceptance for years. Thus it did not come to be accepted in Denmark, the native land of Tycho Brahe, until 1700; while Kepler, because of his urging of it against his former master Mästlin, the mathematician, as well as because of his championing of the Copernican theory, became permanently unacceptable in the chief Protestant seat of learning, the University of Tübingen.

Before proceeding further into the fortunes of the Copernican system, however, it is first imperative, in view of the subsequent rejection of Aristotle by Galileo, to examine upon what bases that system, one of the glories of modern times, was elaborated. For that very system, the foundation of all modern science, is based, not on the principles of Galileo or of Newton, but *on the diametrically opposite principles of Aristotle.*

The fundamental antithesis between the Aristotelian, on the one hand, and the Galilean-Newtonian systems, on the other, lies of course in the conception of motion. In the Aristotelian system, circular motion is primary and perfect, and rectilinear motion, while equally real, is by nature subordinated to it.[15] In

[15] ". . . All movement that is in place, all locomotion, as we term it, is either straight or circular or a combination of these two, which are the only simple movements." *On the Heavens*, 268b. "Further this circular

the Newtonian system, contained in germ in Galileo's *Dialogues of Two New Sciences*,[16] printed in 1638, and upon which Galileo's *scientific* fame principally rests, rectilinear motion is primary and circular motion is simply a modification of it caused by some external force such as gravitation.[17] Thus, whereas for Aristotle circular motion is both natural and primary, for Newton it is not even natural. But the system "whose adoption was to make possible the triumphs of Kepler and Newton in the following century," [18] was not that of Newton but that of Aristotle.

The heliocentric system, first formulated by Aristarchus, a disciple of Aristotle, receives its first full development at the hands of Copernicus in Aristotelian terms. This is so true that it is possible to follow the development of Copernicus almost *verbatim* in the words of Aristotle. Copernicus inaugurates his system thus:

> At the very beginning, we must recognize that the universe is spherical, whether because this form is the most perfect of all, requiring no joining, being wholly integrated: whether because it is most capable of figures, which is most fitting for that which should contain all things and preserve all things: whether because the most absolute parts of

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motion is necessarily primary. For the perfect is naturally prior to the imperfect, and the circle is a perfect thing. This cannot be said of any straight line." *Ibid.*, 269a.

[16] "Mobile quoddam super planum horizontale proiectum mente concipio, omni secluso impedimento: iam constat . . . illius motum aequabilem et perpetuum super ipso plano futurum esse, si planum in infinitum extendatur." *Le Opere di Galileo Galilei* (Firenze, 1897), VIII, "Le Nuove Scienze," Giornata quarta: De motu proiectorum, p. 265.

[17] ". . . We do not know in what manner the ancients explained the question, how the planets come to be retained within certain bounds in these free spaces, and to be drawn off from rectilinear courses, which, left to themselves, they should have pursued, into regular revolutions in curvilinear orbits." *Principia*, transl. F. Cajori (Berkeley, 1946), p. 550. "Every body continues in its state of rest, or uniform motion in a right line, unless it is compelled to change that state by forces impressed upon it." Law I, *op. cit.*, p. 13.

[18] Angus Armitage, *op. cit.*, p. 91.

the world, i. e. the Sun, the Moon and the stars, are seen to be of such a form: whether because all things desire to be terminated by this form, which appears in drops of water and other liquid bodies, when they endeavor to terminate themselves. No less should any one doubt that this form is attributed to the heavenly bodies.[19]

In proving the rotundity of the earth, Copernicus likewise adopts the Aristotelian proofs, which have not been supplanted to this day—and the same terminology.[20]

In chapter 4, Copernicus, having established the sphericity of the universe and of the earth, sets out to show that the movements of the heavenly bodies must likewise be circular. He does this in virtue of the Aristotelian conclusion that there must be simple bodies with a circular motion, and since this is not true of earthly bodies, it must therefore be true of the heavenly bodies.[21] Nor can there be any *real* inequality in these

[19] Bk. I, ch. 1. Aristotle: "It is necessary that the heavens have a spherical shape, for this is the most proper (shape), first both by substance and by nature. It holds universally the priority in figures, both in planes and solids. . . . Since the first figure is that of the first body, and the first body is that which is at the outermost circumference, this body which moves with circular motion will be spherical." Aristotle, *op. cit.*, II, ch. 4.

[20] For example, Copernicus: "Thus Italy does not see Argus, which is apparent to Egypt." Aristotle: "Indeed there are some stars seen in Egypt and in the neighborhood of Cyprus which are not seen in the northerly regions." Copernicus: ". . . Stars in the north which do not set, and others in the south which no longer rise." Aristotle: ". . . Stars which in the north are never beyond observation, in those regions (to the south) rise and set." *Op. cit.*, 298a.

[21] Copernicus: "Next we shall recall that the motion of the heavenly bodies is circular. For the mobility of a sphere is to be revolved in a circle, by that act expressing its form in the most simple body. . . ." Aristotle: "Supposing then, that there is such a thing as simple movement, and that circular movement is an instance of it, and that both movement of a simple body is simple and simple movement is of a simple body, . . . then there must necessarily be some simple body which revolves naturally and in virtue of its own nature with a circular movement . . . beyond the bodies that are on this earth" *op. cit.*, 269a, b. Copernicus: ". . . (circular movement) in which there is to be found neither beginning, nor end, nor disjunction. . . ." Aristotle: "For in circular movement there is neither whence, nor whither, nor middle; nor beginning, nor

motions, as Copernicus again derives from Aristotle.[22] He therefore concludes concerning the heavenly bodies that

> their motion must seem unequal *to us*, either because of the different poles of their circles, or even because the earth is not in the middle of the circles in which they revolve, and to us looking from the earth at the passage of these stars it happens, because of the unequal distances, that those nearer appear greater than those more remote. . . .

Already in Aristotle's time the need had been seen of introducing other concentric circular motions of the heavenly bodies besides the primary uniform motion, in order to explain the apparent inequality of these motions. With true scientific balance, Aristotle realized that in undertaking to reconcile the motions of the heavenly bodies, one was approaching a matter of great difficulty. Consequently he prefaces his thoughts on this subject with the recognition that although it is fitting that one searching for the truth should consider such matters, nevertheless one must be here content with scarcely sufficient reasons—leaving the door open to more adequate reasons in the future. Aristotle's genius is visible in the fact that, instead

end, nor real mid-point; being eternal in time, complete in length and unbreakable." *Op. cit.*, II, ch. 6.

[22] Copernicus: "For it cannot be that any simple celestial body should move unequally in one orbit. For that would have to come about either through the inconstancy of the power of the mover—whether it be incidental, or by nature—or because of the disparity of the body which is revolved. . . . The intellect recoils from both possibilities, and it would be unworthy to think such a thing to exist in them which are constituted in the best order. . . ."

Aristotle: "Furthermore, since everything which is moved is moved by another, it is necessary that the irregularity of the motion would have to be either because of the mover, or because of that which is moved, or both: whether the mover did not move with the same force, or the moved object changed and did not stay the same, or whether both were changed. . . . But none of these things could occur in the heavens. For what is moved has been shown to be first and simple and ungenerated and incorruptible and wholly unchangeable. There is even all the more reason for this to be true of the mover. . . . Whence it is impossible for the motion to be irregular." *Op. cit.*, II, ch. 6.

of treating of this matter of the apparent inequality of the heavenly motions as easy of solution, he explicitly earmarks it as a great difficulty, contenting himself with manifesting this fact and refusing to commit himself absolutely to any of the solutions then available. But it was the recognition on Aristotle's part that, despite appearances, these motions could not be irregular, which led to that continued search for *a fitting harmonization of regular motion with the irregular appearances*—culminating in the Copernican system.[23]

Eudoxus had already provided for Plato the first of the solutions of the apparent inequality of the heavenly motions which Copernicus mentions—different poles to the circles—by supposing two axes whereby the stars could not only move from east to west in the Zodiac, but also from north to south. St. Thomas, in his commentary upon Aristotle, maintains the spirit of the Philosopher, saying of the theories of Eudoxus and those who followed him that

> although on the basis of such suppositions the appearances might be saved, nevertheless it is not necessary to call these suppositions true, since possibly by some other way, not yet discovered by men, the appearance of the stars might be preserved.[24]

It is in this same tentative vein that St. Thomas cites the solution of Ptolemy which provides the second of the solutions

[23] "Two doubts exist (one as to the apparent irregular motions of the heavenly bodies themselves, the other as to why the highest sphere, containing the many fixed stars, should have one motion, but the lower planets many motions for a single body), concerning which one rightly doubts in trying to state what appears. A willingness to attack such doubts should be attributed to modesty rather than to temerity, if, in seeking solidity for philosophy, one contents oneself with scarcely sufficient reasons in a matter in which one has very great doubts. . . . It is therefore good to inquire into such things for greater understanding (although) they have causes we can know little of and are so greatly removed from the things of this earth. Nevertheless, from what will be said it will be seen that these doubts which are investigated are not unreasonable." *Op. cit.*, II, ch. 12.

[24] St. Thomas Aquinas, *In De Coelo et Mundo*, II, l. xvii, no. 2.

Copernicus mentions—that the earth may not be in the middle of the circles.

> And therefore Hipparchus and Ptolemy gave each planet one (more) sphere which they nevertheless held not to be concentric with the supreme sphere, but having another center than the earth; so that when the planet is in that part of the sphere which is most distant from us, the body of the planet seems smaller and of a slower motion; when it is in the opposite part, larger and of faster motion.[25]

With the introduction by Ptolemy of *other centers of rotation besides the earth*, the door had already been opened to the Copernican system. It only remains for Copernicus to eliminate the circles concentric upon the earth, and place in the central position these "circles about another centre"—eventually the sun. It is noteworthy that, in integrating this solution into Aristotelian astronomy, St. Thomas employs very nearly the same words which Copernicus later adopts.

Other centres than the earth having been introduced by Ptolemy, why not other motion than that of the planets? Why should not the earth move? Basing himself upon the fact already mentioned by St. Thomas, that the appearance of motion can be caused equally well either by the movement of that which is seen or by the movement of the one seeing,[26] Copernicus concludes to the diurnal rotation of the earth. "If, therefore, some motion is assigned to the earth, it will appear the same in all things which are without, but in the opposite way, as to those passing by, of which nature is the diurnal revolution first of all."

In order to justify his setting of the earth in motion, Copernicus invokes the Aristotelian principle that that which contains is more perfect than that which is contained, and the

[25] *Ibid.*, no. 5.

[26] St. Thomas: "Quod enim motus appareat, causatur vel ex motu visibilis, vel ex motu videntis." Note 5. Copernicus: "Omnis enim quae videtur secundum locum mutatio, aut est propter spectatae rei motum, aut videntis" Ch. 5.

Aristotelian principle that the perfection of immobility more properly fits the container and mobility the contained.[27]

The earth once in motion on its own axis, Copernicus next argues from the Ptolomaic theory of the *excentrics* to a further motion of the earth.

> For if anyone should deny that the earth is the middle or centre of the universe . . . and therefore believe that the motion of the heavenly bodies appears different because regulated by another centre than the earth, a not inept explanation would thus be provided for the varying apparent motion. . . . Nor would it be surprising, if besides that diurnal revolution, someone should suppose some other motion of the earth (ch. 5).

What is the one objection Copernicus must face in this theory based upon Aristotelian principles? It is the objection that, since the simple bodies of earth have a simple rectilinear motion and the simple bodies of the heavens a circular motion—as he himself holds—for the earth to move with a rotating or circular motion would be contrary to nature. Furthermore, the earth, being in its natural place, should be at rest. Copernicus extricates himself from this difficulty by a further application of Aristotelian principles. Accepting the Aristotelian division of motion (ch. 7), he sets out to show that a circular motion of the earth would be in some sense not violent, but natural.[28] This is ingeniously done by positing that circular

[27] Copernicus: "Since the heavens are that which contain and covers all things, and the common place of everything, it does not immediately appear why motion should not be rather attributed to that which is contained than that which contains, to that which is in place rather than to that which makes it in place. . . . For the condition of immobility is esteemed more noble and divine than that of change and instability, which for this reason belongs rather to the earth than to the universe." Ch. 5, 8. Aristotle: "That which contains or limits is more honorable than that which is limited." *Op. cit.*, II, ch. 13. (Aristotle explicitly uses this principle to show that the earth is not the *real* centre of the universe.) "That which is best needs no action." *Ibid.*, ch. 12.

[28] "In full accord with the Peripatetician physics, he (Copernicus) opposes natural motion to violent motion." A. Koyré, *Nicolas Copernic—Des Révolutions des Orbes Célestes* (Paris, 1934), p. 20.

motion would not remove the earth from its proper place, in virtue of the Aristotelian principle that "circular motion is a motion which remains complete within itself, similar to rest." [29] There is nothing, says Copernicus, so repugnant to the order and form of the universe as for a body to be outside its place. That is why rectilinear motion takes place: the body is seeking its proper place. (This principle of Aristotle which Copernicus employs at a crucial moment could not possibly be more contradictory to Newtonian principles.) Furthermore, the velocity increases with the approach to that place—again Aristotle. But circular motion is always regular, which proves that circular motion is in its proper place—and therefore at rest. Thus the earth, in moving with a circular motion, is fundamentally not moved, but at rest.

To reconcile the presence of both circular and rectilinear motion in connection with the earth, Copernicus has recourse to the principle of Aristotle which he invokes in the beginning of his work, that of the perfection and primacy of circular motion. "Since circular motion is that of the universe and rectilinear motion that of the parts, we can say that there will be circular motion with rectilinear, as animal is present in sickness" (ch. 8). (*Nothing* could be more absolutely contrary to Newton.)

Re-enforcing his argument by the cardinal principle of the immobility of perfection, Copernicus adds: "Moreover, it would seem quite absurd to ascribe motion to the containing or that which makes things in place, and not rather to that which is contained and in place, which is the earth."

The earth has already begun to spin. It only remains now to give the sun, the noblest of the planets according to St. Thomas, its immobility at the centre of the universe and set the other planets, including the earth, in motion around it,

[29] Cf. note 20.

with—to the horror of Mr. Peattie [30]—the ultimate sphere of fixed stars set in a rigid immobility of perfection—" for the condition of immobility is esteemed more noble and divine."

Returning to Ptolemy's lead concerning the excentrics, Copernicus proceeds: " Since the earth is not the center of all revolutions . . . and there are several centres, concerning the centre of the universe it is not a foolhardy question to ask whether it is the gravity of the earth or something other " (ch. 9). Although the theory of universal gravitation is attributed to Newton, actually, some 150 years before, Copernicus explicitly introduces it to justify the sun as centre of the universe, as Newton was later on to do himself.

For I believe gravity to be nothing other than a certain natural appetite (*appetentia*) set in the parts by the divine providence of the Maker of all things, that they might tend toward their unity and integrity, coming together in the form of a globe. Which affection, it is reasonable to believe, exists also in the Sun, Moon and other lights of the planets, that by its efficacy they may remain in the rotundity in which they are represented, while nevertheless effecting their circuits in various ways (ch. 9).

Copernicus therefore concludes:

If therefore the earth has other movements, for example around a centre, they will necessarily be those which appear externally in a similar way to those many motions, among which we find an annual circuit. Hence, if motion is changed from the Sun to the earth and the Sun is conceded immobility, the rising and setting of the signs and the fixed stars, in virtue of which they are made morning and evening stars, will appear the same. The stations of the planets, their recessions and processions will be seen to be, not their motion, but that of the earth, to whom these lend their appearances. Finally the Sun will be considered to occupy the centre of the universe; all of which things, the order with which they succeed each other, and the harmony of the universe, teach us, if we consider the matter as they say, with both eyes (ch. 9).

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[30] " . . . Galileo spoke of the universe and how nothing in it stands still, but all things (contrary to Aristotle), all atoms, all stars, have their motion." Donald Culross Peattie, *art. cit.*

The final problem of Copernicus is to assign to the earth a position in the planets. This is simply done by exchanging the positions which the Sun and the Earth held in the Ptolomaic system, the descending order being thus changed from Sun, Venus, Mercury, Earth, to Earth, Venus, Mercury, Sun. The moon continues in its orbit around the earth. The fact that the other planets are always nearer the earth when the earth is between them and the sun, and farthest from the earth when the sun is between them and the earth, shows that their center belongs more to the Sun, as do, likewise, the revolutions of Venus and Mercury.

It is interesting to note that it is precisely the elimination of that epicycle of Venus, devised to explain why Venus and the Sun are never seen in opposition—which Osiander in his malicious preface cites as an example of the implausibility of astronomy—that permits Copernicus to assign to the earth and moon the position they now hold in the heliocentric system (ch. 9). Thus Copernicus has done away with that "quasi-infinite number of orbs . . . which those were obliged to make who retained the earth in the middle of the universe. . . . But rather is the wisdom of nature to be followed which, just as it most avoids anything superfluous or useless, so it rather vests one thing with many effects." In this universe the outermost planets are still far from the twinkling stars ". . . so great is this workshop of the Greatest and Best" (ch. 10).

With these words Copernicus has completed his exposition of the heliocentric theory. The remainder of the work is concerned with the solution of various particular problems concerning the heavenly bodies.[31]

[31] "Cum in praecedenti libro tres in summa telluris motus exposuerimus, quibus polliciti sumus apparentia siderum omnia demonstrare, id deinceps per partes examinando singula et inquirendo pro posse nostro faciemus." (First sentence of "Liber Secundus." The "Liber Primus," as Copernicus states in his preface is concerned with the "motions of the earth" and "general constitution of the universe.")

As has been seen, and as scholars readily admit, the Copernican theory is simply an organic development within the framework of the traditional Aristotelian philosophy.[32] To speak therefore of a " Copernican Revolution " in the sense of a completely new concept of reality invalidating all that which had gone before is obviously nonsense.

Since the Catholic Church was not wedded to any particular conception of the disposition of the heavenly bodies, the work of Copernicus so Aristotelian in nature, not only received no official opposition within Catholic circles but was hailed as a scientific achievement. Pope Paul III received the work " with pleasure." Already in 1561, at the University of Salamanca, stronghold of the Dominicans, it was specified in the course of astrology and mathematics, that the students were to learn astrology (astronomy), Euclid, and then the system of Ptolemy *or Copernicus*, " ad vota audientium." [33]

It is sometimes gratuitously assumed that the *De Revolutionibus* received its currency thanks to the preface of Osiander who stated that its " hypotheses . . . could not possibly be true." A strange argument. As has been seen Osiander's preface, written against the will of Copernicus, who knew his intention, is specifically concerned with rendering the work harmless, not in respect to Catholic doctrines, but in respect to *Lutheran* doctrines. This he does by affirming that no science pretends to be true, and that no truth can be had except by revelation—meaning, of course, that very personal and unique revelation, in

[32] Johannes Rheticus, the young Protestant disciple of Copernicus, said of the *Narratio Prima*, a preliminary sketch of Copernicus doctrines which he had printed at Nuremberg, that Aristotle and Ptolemy would agree with it. Angus Armitage notes that Rheticus " had been welcomed by a man (Copernicus) whose opinions were at that time more obnoxious to the Wittenberg authorities than to orthodox Catholics." (*Op. cit.*, p. 58.) Rheticus was also to supervise the printing of the *De Revolutionibus Orbium Coelestium*, and it was his temporary absence from Nuremberg on business which allowed Osiander to add his treacherous interpolation.

[33] Rashdall, *The Medieval Universities*, II, Part 1, 77.

no way subject to reason, which was the peculiar property of Martin Luther. To suppose that Osiander would have done anything to facilitate the acceptance of a doctrine against which he, as a leader of the Reform, was irrevocably committed, is too fantastic to imagine. Since he could not prevent the printing of the book, he simply did his best to nullify it, with a special regard to any detriment it might cause to the tenets of Luther and Melancthon.

Copernicus' own preface, on the other hand—and this again is readily admitted by scholars—makes it quite clear that he is proposing his system, initiated from observation and derived by the use of a reason capable of attaining to objective truth, as a demonstration of a *real* order existing in the universe. Was this a revolutionary conception on the part of Copernicus, this conviction that reason was capable of explaining the workings of the universe without recourse to revelation—an imprudence temporarily obviated by the happy interpolation of a preface stating that the author had no pretension of teaching the truth? It could be so only in the minds of the Reformers who looked upon reason as a dangerous menace to the divine irrationality of their God. The orthodox doctrine of the Catholic Church, however, held then, as it does now, that human reason is capable of perceiving the real order of the universe, an order of which God is the author. There can therefore never be any contradiction between the order perceived by reason and divine revelation, since God is the author of both "—and God cannot deny Himself, nor ever contradict truth by truth." [34] That such was the attitude not only of Copernicus, but also of his Catholic contemporaries, is attested by the fact that Bishop Giese, the Catholic prelate and life-long friend of Copernicus, scarcely two months after the apparition of the *De Revolutionibus* and the death of the astronomer, wrote to Johannes Rheticus, July 26, 1543, supplying the final details of Copernicus' biography

[34] *Concilium Vaticanum,* Sess. 3, cap. 4.

that was to *replace* the preface of Osiander in any future edition.[35]

However, that the "Copernican revolution" was such in reference to the new "revelation" inaugurated by Protestantism seems only too evident. In effect the Protestants opposed the Copernican system from the start on the basis of the infallibility of their personal interpretations of Scripture. At the University of Wittenberg, the Rome of Protestantism, neither Copernicus nor his theory were mentioned in a single lecture from 1540 to 1561.[36] Calvin from Geneva quoted Psalm 92: "For He hath established the world which shall not be moved," and added: "Who will venture to place the authority of Copernicus above that of the Holy Spirit?"[37] The gradual acceptance of the Copernican system could have, therefore, for the Protestants, no other result than the destruction of their belief in the divine inerrancy of their interpretation of the Scriptures, an effect further heightened by the later destruction of their interpretation of the six days of creation, in the nineteenth century.

The power of reason to arrive at truth having been previously invalidated for the Protestants by Luther, the destruction of the infallibility of their interpretations of Scripture logically leaves the Protestant mind devoid of all certainty, whether divine or human. In this way the Protestant revolt may be truly said to have inaugurated the modern era, in that the pious Reformers are, ironically enough, the spiritual parents of the modern godless agnostic.

[35] In his letter Bishop Giese refers to Osiander's preface as a "great crime committed under the cover of confidence by an envious person who in his irritation at having to abandon his mechanically acquired conviction . . . abuses the kindness of the author to discredit his work." Herman Kesten, *op. cit.*, p. 302.

[36] Hermann Kesten, *op. cit.*, p. 317.

[37] Bertrand Russell, *A History of Western Philosophy* (New York, 1945), p. 528.

Tycho Brahe, born three years after Copernicus, was by the accuracy of his observations, his continuator in the gradual establishment of the Copernican system. He regarded Copernicus as " an incomparable man " and treasured in his Danish observatory one of the crude instruments of Copernicus sent him by the canons of Frauenburg. But whereas Copernicus, the Catholic, did not hesitate to hold the heliocentric system since it appeared consonant with reason, Tycho, the Protestant, would not hold it because it " contradicts not only the principles of Physics, but also *the authority of the Holy Scriptures*, which repeatedly confirm the stability of the Earth." [38] He therefore devised his own system in 1582, whereby the planets moved around the sun in accord with the Copernican system, but the sun itself continued to move around the earth. Even on his death bed at Prague in 1601, where the two greatest astronomers of their day, the Protestants Brahe and Kepler, had found a welcome understanding of their work, the one as Imperial Mathematician, the other as his assistant, to the Catholic Emperor Rudolph II, Brahe begged Kepler to develop his system rather than that of Copernicus.

But Johann Kepler, who, rather than Galileo, is recognized as the astronomical link between Copernicus and Newton, had long since become a Copernican. His devotion to that system was one of the principal reasons why he found himself at that time not in Protestant but in Catholic territory—a happy circumstance whereby he fell heir to the priceless catalogue of the stars established by Tycho Brahe. Kepler's troubles had begun after he had accepted a post as Provincial Mathematician at Graz following his graduation in theology at the Protestant University of Tübingen, when he sent back his first Copernican work, *The Cosmographic Mystery*, to his master Mästlin for publication. The Senate at the University demurred but finally,

[38] Angus Armitage, *op. cit.*, p. 166. John Allyn Gade, *The Life and Times of Tycho Brahe* (New York, 1947), pp. 94, 95.

on condition that no attempt be made in the work to reconcile the Copernican system with Scripture, allowed publication in December, 1596. The young astronomer further antagonized the worthy doctors by his urging of the adoption of the Gregorian calendar, against which his master Mästlin was then engaged in writing. Thus, when he lost his post at Graz, and applied to Mästlin to be re-accepted at the University of Tübingen even as a medical student, he received no answer until long after—and then it was in terms of a polite, but firm, refusal. Invited by Tycho, he joined that astronomer at the observatory which had been equipped for him by Rudolph II near Prague, and due to Tycho's influence was likewise appointed Imperial Mathematician. Succeeding Tycho in 1601 upon the latter's death, Kepler continued the work which was to result in the establishment of the three famous laws whereby the acceptance of the Copernican system was definitely guaranteed. Removing to Linz upon the death of Rudolph II, he was, among other things, excommunicated by Hitzler, the Evangelical pastor there. In the meantime the Jesuits, many of whom were numbered among the best astronomers of the day, not only had adopted Kepler, but one of them, Father Guldin, was doing his best to gain Kepler to Catholicism.

In 1597, Kepler had written to Galileo for the first time, enclosing a copy of his *Cosmographic Mystery.* Much impressed, Galileo had answered immediately from Padua, where he was then teaching. In this letter Galileo states that he had long held the Copernican system, had drawn up many reasons in favor of it and refutations of the reasons opposing it. He had deferred publication, he said, "lest I should meet with the same fate as our master, Copernicus, who, although he has earned immortal fame for himself among many, is with an infinite number (so great is the number of fools) considered fit only for raillery and derision." [39] In the forefront of those

[39] Hermann Kesten, *op. cit.*, pp. 348, 349.

who derided Copernicus were, needless to say the Reformers, who even during his lifetime, had burlesqued him in the nearby towns of Elbing and Danzig. From this letter it is equally evident also that Galileo in no way feared official opposition on the part of the Church.[40] This impression is further confirmed by a letter of Kepler to Herwart, March 28, 1605, in which he says: "Wisely, I think, has the Roman Church, while condemning future-telling astrology . . . left the philosophy of Copernicus alone." [41] Even, Sir David Brewster, before undertaking to constitute Galileo one of his "Martyrs of Science," feels obliged to preface that undertaking with the statement:

> The Church party, particularly its highest dignitaries . . . flanked on one side by the logic of the schools and on the other by the popular interpretation of Scripture, and backed by the strong arm of the civil power, . . . were not disposed to interfere with the prosecution of science, however much they may have dreaded its influence.[42]

It is upon this scene of—at least in the Catholic world—scientific interest and ecclesiastical imperturbability that Galileo enters the lists. Galileo himself records in his now famous *Dialogue of the Two Greatest Systems of the World* how he had first come as a young man to hear of the Copernican theory in virtue of its free discussion as a scientific question.[43]

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(*To be concluded*)

[40] Cf. "Galileo," *Encyclopaedia Britannica* (Chicago, 1947), IX, 979.

[41] "Propterea sapienter factum ab ecclesia Romana puto, quod cum astrologiam judiciariam . . . damnaverit, illam tamen Copernici philosophiam in medio suspensam reliquit." *Joannis Kepleri Opera Omnia* (ed. C. Frisch, Frankfurt, 1859), II, 87.

[42] Sir David Brewster, *The Martyrs of Science* (London, 1870), pp. 47-48.

[43] *Opere*, VII, "Dialogo Sopro I Due Massimi Sistemi Del Mondo," Giornata secunda, p. 154.