

TO HIS HOLINESS, POPE PAUL III, NICHOLAS COPERNICUS' PREFACE TO HIS BOOKS ON THE REVOLUTIONS

I can readily imagine, Holy Father, that as soon as some people hear that in
5 this volume, which I have written about the revolutions of the spheres of the uni-
verse, I ascribe certain motions to the terrestrial globe, they will shout that I must
be immediately repudiated together with this belief. For I am not so enamored
of my own opinions that I disregard what others may think of them. I am aware
that a philosopher's ideas are not subject to the judgement of ordinary persons,
10 because it is his endeavor to seek the truth in all things, to the extent permitted
to human reason by God. Yet I hold that completely erroneous views should
be shunned. Those who know that the consensus of many centuries has sanctioned
the conception that the earth remains at rest in the middle of the heaven as its
center would, I reflected, regard it as an insane pronouncement if I made the
15 opposite assertion that the earth moves. Therefore I debated with myself for
a long time whether to publish the volume which I wrote to prove the earth's
motion or rather to follow the example of the Pythagoreans and certain others,
who used to transmit philosophy's secrets only to kinsmen and friends, not
in writing but by word of mouth, as is shown by Lysis' letter to Hipparchus. And
20 they did so, it seems to me, not, as some suppose, because they were in some
way jealous about their teachings, which would be spread around; on the contrary,
they wanted the very beautiful thoughts attained by great men of deep devotion
not to be ridiculed by those who are reluctant to exert themselves vigorously
in any literary pursuit unless it is lucrative; or if they are stimulated to the non-
25 acquisitive study of philosophy by the exhortation and example of others, yet
because of their dullness of mind they play the same part among philosophers
as drones among bees. When I weighed these considerations, the scorn which I had
reason to fear on account of the novelty and unconventionality of my opinion
almost induced me to abandon completely the work which I had undertaken.
30 But while I hesitated for a long time and even resisted, my friends drew me
back. Foremost among them was the cardinal of Capua, Nicholas Schönberg,
renowned in every field of learning. Next to him was a man who loves me dearly,
Tiedemann Giese, bishop of Chełmno, a close student of sacred letters as well
as of all good literature. For he repeatedly encouraged me and, sometimes
35 adding reproaches, urgently requested me to publish this volume and finally
permit it to appear after being buried among my papers and lying concealed not
merely until the ninth year but by now the fourth period of nine years. The
same conduct was recommended to me by not a few other very eminent scholars.
They exhorted me no longer to refuse, on account of the fear which I felt, to make
40 my work available for the general use of students of astronomy. The crazier my
doctrine of the earth's motion now appeared to most people, the argument ran,
so much the more admiration and thanks would it gain after they saw the
publication of my writings dispel the fog of absurdity by most luminous proofs.
Influenced therefore by these persuasive men and by this hope, in the end I
45 allowed my friends to bring out an edition of the volume, as they had long be-
sought me to do.

Translation by Edward Rosen

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However, Your Holiness will perhaps not be greatly surprised that I have dared to publish my studies after devoting so much effort to working them out that I did not hesitate to put down my thoughts about the earth's motion in written form too. But you are rather waiting to hear from me how it occurred to me to venture to conceive any motion of the earth, against the traditional opinion of astronomers and almost against common sense. I have accordingly no desire to conceal from Your Holiness that I was impelled to consider a different system of deducing the motions of the universe's spheres for no other reason than the realization that astronomers do not agree among themselves in their investigations of this subject. For, in the first place, they are so uncertain about the motion of the sun and moon that they cannot establish and observe a constant length even for the tropical year. Secondly, in determining the motions not only of these bodies but also of the other five planets, they do not use the same principles, assumptions, and explanations of the apparent revolutions and motions. For while some employ only homocentrics, others utilize eccentrics and epicycles, and yet they do not quite reach their goal. For although those who put their faith in homocentrics showed that some nonuniform motions could be compounded in this way, nevertheless by this means they were unable to obtain any incontrovertible result in absolute agreement with the phenomena. On the other hand, those who devised the eccentrics seem thereby in large measure to have solved the problem of the apparent motions with appropriate calculations. But meanwhile they introduced a good many ideas which apparently contradict the first principles of uniform motion. Nor could they elicit or deduce from the eccentrics the principal consideration, that is, the structure of the universe and the true symmetry of its parts. On the contrary, their experience was just like some one taking from various places hands, feet, a head, and other pieces, very well depicted, it may be, but not for the representation of a single person; since these fragments would not belong to one another at all, a monster rather than a man would be put together from them. Hence in the process of demonstration or "method", as it is called, those who employed eccentrics are found either to have omitted something essential or to have admitted something extraneous and wholly irrelevant. This would not have happened to them, had they followed sound principles. For if the hypotheses assumed by them were not false, everything which follows from their hypotheses would be confirmed beyond any doubt. Even though what I am now saying may be obscure, it will nevertheless become clearer in the proper place.

For a long time, then, I reflected on this confusion in the astronomical traditions concerning the derivation of the motions of the universe's spheres. I began to be annoyed that the movements of the world machine, created for our sake by the best and most systematic Artisan of all, were not understood with greater certainty by the philosophers, who otherwise examined so precisely the most insignificant trifles of this world. For this reason I undertook the task of rereading the works of all the philosophers which I could obtain to learn whether anyone had ever proposed other motions of the universe's spheres than those expounded by the teachers of astronomy in the schools. And in fact first I found in Cicero that Hicetas supposed the earth to move. Later I also discovered in Plutarch that certain others were of this opinion. I have decided to set his words down here, so that they may be available to everybody:

Some think that the earth remains at rest. But Philolaus the Pythagorean believes that, like the sun and moon, it revolves around the fire in an oblique circle. Heraclides of Pontus and Ecphantus the Pythagorean make the earth move, not in a progressive motion, but like a wheel in a rotation from west to east about its own center.

Therefore, having obtained the opportunity from these sources, I too began to consider the mobility of the earth. And even though the idea seemed absurd, nevertheless I knew that others before me had been granted the freedom to imagine any circles whatever for the purpose of explaining the heavenly phenomena. 10 Hence I thought that I too would be readily permitted to ascertain whether explanations sounder than those of my predecessors could be found for the revolution of the celestial spheres on the assumption of some motion of the earth.

Having thus assumed the motions which I ascribe to the earth later on in the volume, by long and intense study I finally found that if the motions of the 15 other planets are correlated with the orbiting of the earth, and are computed for the revolution of each planet, not only do their phenomena follow therefrom but also the order and size of all the planets and spheres, and heaven itself is so linked together that in no portion of it can anything be shifted without disrupting the remaining parts and the universe as a whole. Accordingly in the arrangement of 20 the volume too I have adopted the following order. In the first book I set forth the entire distribution of the spheres together with the motions which I attribute to the earth, so that this book contains, as it were, the general structure of the universe. Then in the remaining books I correlate the motions of the other planets and of all the spheres with the movement of the earth so that I may thereby 25 determine to what extent the motions and appearances of the other planets and spheres can be saved if they are correlated with the earth's motions. I have no doubt that acute and learned astronomers will agree with me if, as this discipline especially requires, they are willing to examine and consider, not superficially but thoroughly, what I adduce in this volume in proof of these matters. However, 30 in order that the educated and uneducated alike may see that I do not run away from the judgement of anybody at all, I have preferred dedicating my studies to Your Holiness rather than to anyone else. For even in this very remote corner of the earth where I live you are considered the highest authority by virtue of the loftiness of your office and your love for all literature and astronomy too. Hence 35 by your prestige and judgement you can easily suppress calumnious attacks although, as the proverb has it, there is no remedy for a backbite.

Perhaps there will be babblers who claim to be judges of astronomy although completely ignorant of the subject and, badly distorting some passage of Scripture to their purpose, will dare to find fault with my undertaking and censure it. 40 I disregard them even to the extent of despising their criticism as unfounded. For it is not unknown that Lactantius, otherwise an illustrious writer but hardly an astronomer, speaks quite childishly about the earth's shape, when he mocks those who declared that the earth has the form of a globe. Hence scholars need not be surprised if any such persons will likewise ridicule me. Astronomy is 45 written for astronomers. To them my work too will seem, unless I am mistaken, to make some contribution also to the Church, at the head of which Your Holiness now stands. For not so long ago under Leo X the Lateran Council considered the problem of reforming the ecclesiastical calendar. The issue remained undecided then only because the lengths of the year and month and the motions of the sun and moon were regarded as not yet adequately measured. From that time on, at the suggestion of that most distinguished man, Paul, bishop of Fossombrone, who was then in charge of this matter, I have directed my attention to a more 5 precise study of these topics. But what I have accomplished in this regard, I leave to the judgement of Your Holiness in particular and of all other learned astronomers. And lest I appear to Your Holiness to promise more about the usefulness of this volume than I can fulfill, I now turn to the work itself.

NICHOLAS COPERNICUS' REVOLUTIONS *Book One*

INTRODUCTION

5 Among the many various literary and artistic pursuits which invigorate men's
minds, the strongest affection and utmost zeal should, I think, promote the studies
concerned with the most beautiful objects, most deserving to be known. This
is the nature of the discipline which deals with the universe's divine revolutions,
the asters' motions, sizes, distances, risings and settings, as well as the causes
of the other phenomena in the sky, and which, in short, explains its whole ap-
10 pearance. What indeed is more beautiful than heaven, which of course contains all
things of beauty? This is proclaimed by its very names [in Latin], *caelum* and
mundus, the latter denoting purity and ornament, the former a carving. On account
of heaven's transcendent perfection most philosophers have called it a visible god.
If then the value of the arts is judged by the subject matter which they treat,
15 that art will be by far the foremost which is labeled astronomy by some, astrology
by others, but by many of the ancients, the consummation of mathematics. Un-
questionably the summit of the liberal arts and most worthy of a free man, it is
supported by almost all the branches of mathematics. Arithmetic, geometry, optics,
surveying, mechanics and whatever others there are all contribute to it.

20 Although all the good arts serve to draw man's mind away from vices and
lead it toward better things, this function can be more fully performed by this
art, which also provides extraordinary intellectual pleasure. For when a man is
occupied with things which he sees established in the finest order and directed by
divine management, will not the unremitting contemplation of them and a certain
25 familiarity with them stimulate him to the best and to admiration for the Maker
of everything, in whom are all happiness and every good? For would not the godly
Psalmist [92:4] in vain declare that he was made glad through the work of the
Lord and rejoiced in the works of His hands, were we not drawn to the con-
templation of the highest good by this means, as though by a chariot?

30 The great benefit and adornment which this art confers on the commonwealth
(not to mention the countless advantages to individuals) are most excellently
observed by Plato. In the *Laws*, Book VII, he thinks that it should be cultivated
chiefly because by dividing time into groups of days as months and years, it would
keep the state alert and attentive to the festivals and sacrifices. Whoever denies
35 its necessity for the teacher of any branch of higher learning is thinking foolishly,
according to Plato. In his opinion it is highly unlikely that anyone lacking the
requisite knowledge of the sun, moon, and other heavenly bodies can become and
be called godlike.

40 However, this divine rather than human science, which investigates the loftiest
subjects, is not free from perplexities. The main reason is that its principles and
assumptions, called "hypotheses" by the Greeks, have been a source of dis-
agreement, as we see, among most of those who undertook to deal with this subject,
and so they did not rely on the same ideas.

Of all things visible, the highest is the heaven of the fixed stars. This, I see, is doubted by nobody. But the ancient philosophers wanted to arrange the planets in accordance with the duration of the revolutions. Their principle assumes that of objects moving equally fast, those farther away seem to travel more slowly, as is proved in Euclid's *Optics*. The moon revolves in the shortest period of time because, in their opinion, it runs on the smallest circle as the nearest to the earth. The highest planet, on the other hand, is Saturn, which completes the biggest circuit in the longest time. Below it is Jupiter, followed by Mars.

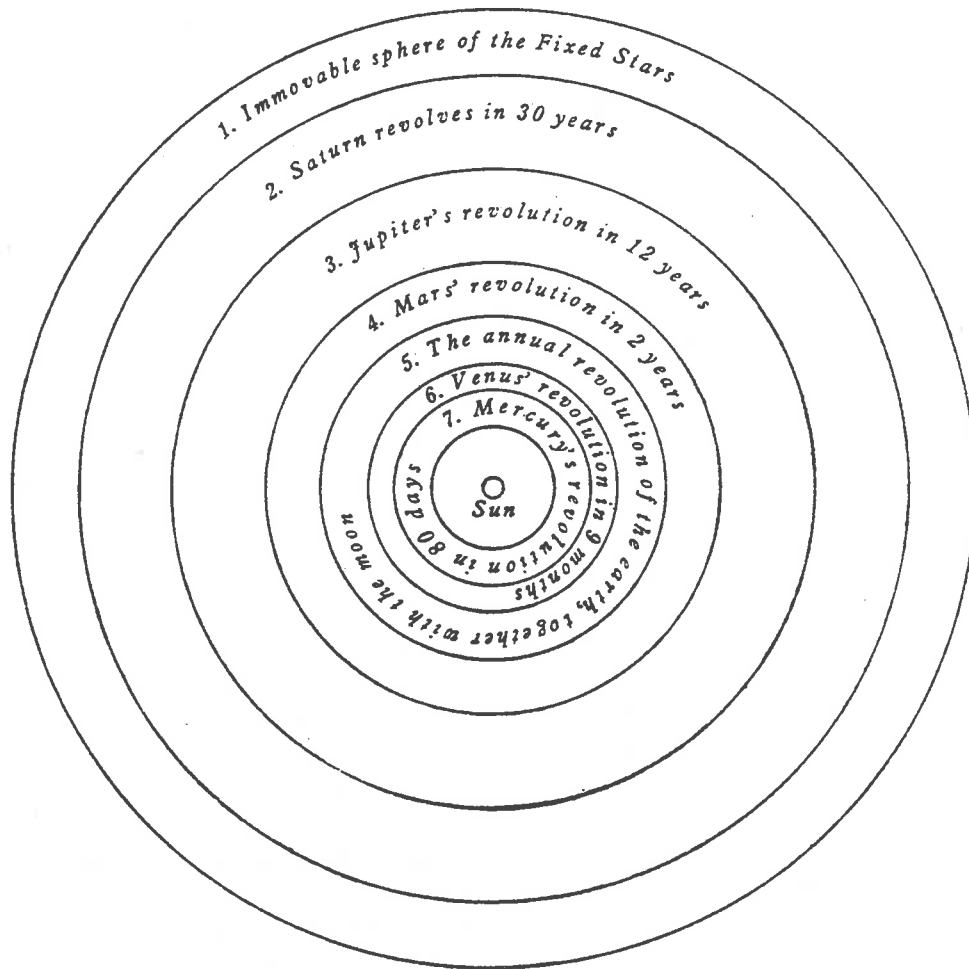
With regard to Venus and Mercury, however, differences of opinion are found. For, these planets do not pass through every elongation from the sun, as the other planets do. Hence Venus and Mercury are located above the sun by some authorities, like Plato's *Timaeus* [38 D], but below the sun by others, like Ptolemy [*Synaxis*, IX, 1] and many of the moderns. Al-Bitruji places Venus above the sun, and Mercury below it. . . .

In my judgement, therefore, we should not in the least disregard what was familiar to Martianus Capella, the author of an encyclopedia, and to certain other Latin writers. For according to them, Venus and Mercury revolve around the sun as their center. . . .

If anyone seizes this opportunity to link Saturn, Jupiter, and Mars also to that center, provided he understands their spheres to be so large that together with Venus and Mercury the earth too is enclosed inside and encircled, he will not be mistaken, as is shown by the regular pattern of their motions.

For [these outer planets] are always closest to the earth, as is well known, about the time of their evening rising, that is, when they are in opposition to the sun, with the earth between them and the sun. On the other hand, they are at their farthest from the earth at the time of their evening setting, when they become invisible in the vicinity of the sun, namely, when we have the sun between them and the earth. These facts are enough to show that their center belongs more to the sun, and is identical with the center around which Venus and Mercury likewise execute their revolutions. . . .

Hence I feel no shame in asserting that this whole region engirdled by the moon, and the center of the earth, traverse this grand circle amid the rest of the planets in an annual revolution around the sun. Near the sun is the center of the universe. Moreover, since the sun remains stationary, whatever appears as a motion of the sun is really due rather to the motion of the earth. In comparison with any other spheres of the planets, the distance from the earth to the sun has a magnitude which is quite appreciable in proportion to those dimensions. But the size of the universe is so great that the distance earth-sun is imperceptible in relation to the sphere of the fixed stars. This should be admitted, I believe, in preference to perplexing the mind with an almost infinite multitude of spheres, as must be done by those who kept the earth in the middle of the universe. On the contrary, we should rather heed the wisdom of nature. Just as it especially avoids producing anything superfluous or useless, so it frequently prefers to endow a single thing with many effects.



All these statements are difficult and almost inconceivable, being of course opposed to the beliefs of many people. Yet, as we proceed, with God's help I shall make them clearer than sunlight, at any rate to those who are not unacquainted with the science of astronomy. Consequently, with the first principle remaining intact, for nobody will propound a more suitable principle than that the size of the spheres is measured by the length of the time, the order of the spheres is the following, beginning with the highest.

The first and the highest of all is the sphere of the fixed stars, which contains itself and everything, and is therefore immovable. It is unquestionably the place of the universe, to which the motion and position of all the other heavenly bodies are compared. Some people think that it also shifts in some way. A different explanation of why this appears to be so will be adduced in my discussion of the earth's motion [I, 11].

[The sphere of the fixed stars] is followed by the first of the planets, Saturn, which completes its circuit in 30 years. After Saturn, Jupiter accomplishes its revolution in 12 years. Then Mars revolves in 2 years. The annual revolution takes the series' fourth place, which contains the earth, as I said [earlier in I, 10], together with the lunar sphere as an epicycle. In the fifth place Venus returns

in 9 months. Lastly, the sixth place is held by Mercury, which revolves in a period of 80 days.

At rest, however, in the middle of everything is the sun. For in this most beautiful temple, who would place this lamp in another or better position than that from which it can light up the whole thing at the same time? For, the sun is not inappropriately called by some people the lantern of the universe, its mind by others, and its ruler by still others. [Hermes] the Thrice Greatest labels it a visible god, and Sophocles' Electra, the all-seeing. Thus indeed, as though seated on a royal throne, the sun governs the family of planets revolving around it. Moreover, the earth is not deprived of the moon's attendance. On the contrary, as Aristotle says in a work on animals, the moon has the closest kinship with the earth. Meanwhile the earth has intercourse with the sun, and is impregnated for its yearly parturition.

In this arrangement, therefore, we discover a marvelous symmetry* of the universe, and an established harmonious linkage between the motion of the spheres and their size, such as can be found in no other way. For this permits a not inattentive student to perceive why the forward and backward arcs appear greater in Jupiter than in Saturn and smaller than in Mars, and on the other hand greater in Venus than in Mercury. This reversal in direction appears more frequently in Saturn than in Jupiter, and also more rarely in Mars and Venus than in Mercury. Moreover, when Saturn, Jupiter, and Mars rise at sunset, they are nearer to the earth than when they set in the evening or appear at a later hour. But Mars in particular, when it shines all night, seems to equal Jupiter in size, being distinguished only by its reddish color. Yet in the other configurations it is found barely among the stars of the second magnitude, being recognized by those who track it with assiduous observations. All these phenomena proceed from the same cause, which is in the earth's motion.

Yet none of these phenomena appears in the fixed stars. This proves their immense height, which makes even the sphere of the annual motion, or its reflection, vanish from before our eyes. For, every visible object has some measure of distance beyond which it is no longer seen, as is demonstrated in optics. From Saturn, the highest of the planets, to the sphere of the fixed stars there is an additional gap of the largest size. This is shown by the twinkling lights of the stars. By this token in particular they are distinguished from the planets, for there had to be a very great difference between what moves and what does not move. So vast, without any question, is the divine handiwork of the most excellent Almighty.

* a better translation of "symmetriam"
would be "commensurability." - OG