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THE life span of Copernicus covers a period in history filled with movement in many spheres of human endeavour. It was an age of intolerance and reaction on the one hand and of high adventure and daring on the other.

It was the time when Michelangelo was at work in the realm of art; when Martin Luther was breaking with traditional theology and fighting for freedom of thought and conscience in the realm of religion; when Paracelsus was vitalizing mediæval medicine and Vesalius was making of anatomy a modern science. It was the time when the Moors with their rich Arabic learning were being pushed out of Spain, while Italy, the main centre of European scholarship, was gradually awakening from an intermittent sleep of twelve centuries. It was the time when Christopher Columbus was sailing uncharted seas to discover the islands of a new continent. It was at this time that Copernicus turned his back upon the ancient cosmologies and gave the world the heliocentric model of the Universe.

In the thirteenth century the Teutonic Knights had founded the town of Torun or Thorn near the mouth of the Vistula. This became an important trading port of the Hanseatic League. From Cracow, the chief town of Poland, a prosperous merchant named Niklas Koppernigk moved to Torun, married the daughter of a Polish-German merchant of that town, and in 1473 their fourth child, Niklas, was born. This boy grew up to become one of the makers of modern thought. When he reached the stage of productive scholarship, he followed the custom of the scholars of his day by publishing his works in Latin, and like so many of them he Latinized his name as author. Thus we know him not as Niklas Koppernigk, but as Copernicus.

COPERNICUS, 1473-1543

The education of Copernicus was long and varied. From the school of Torun he went to the University of Cracow in 1491. Here he found a strong school of mathematics and astronomy and no doubt studied the only two cosmologies that had survived the centuries since the rich speculative and mathematical period of Greek science. The simple Aristotelian system was based upon the geocentric universe of Pythagoras. The more complicated Ptolemaic system was built upon the ingenious work of the great Greek geometers who used circles and epicycles to reproduce the apparent motions of sun, moon and planets. While the Earth was not placed at the centre of these circles, it was still within the circles of all the heavenly bodies, and thus sun, moon, planets and stars moved around it.

In 1496 Copernicus went to Bologna where he worked at the school of law for four years. Here too he found astronomical interests in the observations and theories of the professor of astronomy, a brilliant man with an independent, critical mind, a leader in the current revival of Platonism. Copernicus next went to Rome where he took private pupils in Mathematics, but a year later he resumed his legal studies at Padua. Here he also studied Greek and began his wide reading in Greek science which led to his discovering for himself the half-forgotten speculations of Heraclides, Ecphantus and Hicetas on the axial rotation of the earth, and the heliocentric system of Aristarchus of Samos. This last was indeed a forerunner of the great scientific life-work of Copernicus, but it had been backed up in the third century B.C. by not one logical argument based upon astronomical observation which could overthrow the amazing partial success of the elaborate systems built upon the epicycles of Eudoxus.

Leaving Padua, Copernicus went to Ferrara where in 1503 he obtained his doctorate in Canon Law. He then returned to Padua and applied himself to the study of medicine

until the end of the year 1505. In the meantime his uncle, the Bishop of Varmia or Ermland, had succeeded in getting this scholarly nephew elected to a canonry at Frauenburg Cathedral. This appointment imposed no obligation to advance in ecclesiastical position beyond the first vows necessary for admission, and beyond this first stage Copernicus never went although he remained a member of the Chapter until his death thirty-seven years later.

For six years after taking up his residence as a Canon of Frauenburg, Copernicus served as medical attendant upon his uncle at the Bishop's palace which was the castle of Heilsburg. Here he was able to devote time to astronomical pursuits as well as to exercise the art of healing amongst the ecclesiastics and the poor of the diocese, on one occasion being summoned to Königsberg by the Duke of Prussia to attend a high official in his grave illness. At this time, too, he became experienced in political and administrative work. Varmia was trying to maintain a measure of independence with the powerful Teutonic Knights on three sides and Poland on the fourth. The Bishop had many problems arising from a population partly German, partly Polish, within his own principality; and also in neighbouring West Prussia where he was asked to mediate in the racial dispute. Copernicus carried out diplomatic missions for his uncle and after the Bishop's death he was entrusted with the temporal and spiritual administration of the remoter parts of the diocese. Later when war developed between Poland and East Prussia involving the would-be neutral territory of Varmia with bombardment, raids and pillage, Copernicus proved himself the strong man with high qualities of leadership and practical foresight. At the peace conference following the 1521 armistice it was Copernicus who presented the claims of Varmia for war damage.

The coinage of the Prussian states, already debased before the war, now presented very serious problems, both internally

and in neighbouring states. Copernicus placed before the local diet a scheme for monetary reform, and in a report published first in German and later in Latin he set forth his plan for recoinage and enunciated what later became known as Gresham's Law.

During these years with their multifarious duties, Copernicus had laid the foundations of his planetary theory and written the first draft of *De Revolutionibus Orbium Coelestium.* He had used the primitive instruments then in vogue to make observations upon some of which the arguments in favour of his theory were based. He had published accounts of the construction of a meridian quadrant and of a Ptolemaic astrolabe. One work only of a purely literary character came from his pen. It was his Latin translation of the Greek Epistles of the poet Simocatta, published in Cracow in 1509 when he was in that city on diplomatic business.

For six months in 1523 Copernicus was the Administrator-General of the diocese. Then a new Bishop was appointed and thereafter Copernicus was less burdened with the affairs of the world about him and could give closer attention to the astronomical problems which had absorbed his thoughts for so many years. Peace had come to the land with the triumph of Poland over the Teutonic Knights; but there could be no peace in the minds of thinking men and seekers after truth. Intolerance was growing and was soon to reach new peaks of viciousness in defence of orthodoxy against the teachings of Luther and against any scholarly work that cast a shadow of doubt upon that amazing synthesis, by St. Thomas Aquinas and other Church Fathers, of Judaic thought, Christian doctrine and Greek philosophy and science.

In the years 1523-32 Copernicus revised the manuscript of his great book, but apparently he made no attempt to publish it. It was known to exist, however, but only a very few

scholars had the vision and the courage to be openly interested. In 1536 Cardinal Schönberg of Capua wrote to Copernicus as follows:

Having constantly heard of your talent, I have begun to honour you more fully, and to congratulate our countrymen amongst whom you have flourished with so great renown. For I had perceived that you were not only well versed in the works of the old mathematicians, but also had propounded a new theory of the universe. By it you teach that the earth moves, that the sun is at the bottom of the universe, and indeed holds the middle place. That the eighth heaven remains immovable and eternally fixed. That the moon, with the elements included in her sphere, placed between the heaven of Mars and Venus, revolves in a yearly course round the sun. And that you have written commentaries on this whole theory of astronomy, and have reduced into tables the motions of the planets, computed from calculations, to the great admiration of everyone. Wherefore I beseech you, most learned man, if I am not troubling you, to impart this your discovery to the learned, and also to send to me in the first place your lucubrations concerning the sphere of the universe, with the tables, and anything else you have pertaining to the same matter. And if you will gratify me in this, you will find that you have to do with a man careful of your name, and one anxious to do justice to such great talent. Farewell. At Rome, Calends of November, 1536.

In 1539 a youthful German professor of mathematics came to visit Copernicus at Frauenburg. His name was Joachim von Lauchen, alias Rheticus, and as he was one of Melanchthon's men from the Protestant University at Wittenberg, not only was he running a risk himself remaining in an atmosphere of latent hostility and suspicion, but his presence inevitably focused suspicion on Copernicus. Nevertheless the Canon of Frauenburg welcomed Rheticus, expounded his cosmology, encouraged him to summarize the manuscript and to publish the summary in Danzig in 1540. On his next visit Rheticus

summarized the chapters dealing with plane and spherical trigonometry which Copernicus had brought together and generalized from the works of Ptolemy, and these he published at Wittenberg in 1542.

Copernicus had obviously withheld his book lest its publication should lead to open opposition to his investigations, but he now wrote to Osiander, a Lutheran theologian and an able mathematician, asking him whether in his judgement the work would give offence. Osiander's reply dated April 20, 1541, is in part thus " . . . I have always felt about hypotheses that they are not articles of faith, but bases of calculation. . ."

Copernicus, now nearing seventy years of age, at length determined to publish his completed work. He inscribed his Preface "To the Most Holy Lord Pope Paul III", Osiander wrote an anonymous foreword, and Rheticus arranged that the book should be printed at Nürnberg. Soon after this Copernicus was stricken with paralysis from which he never recovered though he lingered on for a few months. On May 24, 1543, the first copy of *De Revolutionibus* was received from the publishers. It was placed in his hands. He saw it and was glad. A few hours later Copernicus was dead.

Four hundred years ago the words of Osiander supplied a temporary and partial camouflage for the dynamite which the book contained. Copernicus had written,

First and above all lies the sphere of the fixed stars, containing itself and all things, for that very reason immovable; in truth the frame of the universe, to which the motion and position of all other stars are referred. Though some men think it to move in some way, we assign another reason why it appears to do so in our theory of the movement of the earth. Of the moving bodies first comes Saturn, who completes his circuit in xxx years. After him, Jupiter, moving in a twelve year revolution. Then Mars, who revolves biennially. Fourth in order an annual cycle takes place, in which we have said is contained the earth, with the lunar orbit as an epicycle. In the

fifth place Venus is carried round in nine months. Then Mercury holds the sixth place, circulating in the space of eighty days. In the midst of all dwells the Sun. Who indeed in this most beautiful temple would place the torch in any other or better place than one whence it can illuminate the whole at the same time? Not ineptly, some call it the lamp of the universe, others its mind, others again its ruler–Trismegistus, the visible God, Sophocles' Electra, the contemplation of all things. And thus rightly in as much as the Sun, sitting on a royal throne, governs the circumambient family of stars. . . We find, therefore, under this orderly arrangement, a wonderful symmetry in the universe, and a definite relation of harmony in the motion and magnitude of the orbs, of a kind which it is not possible to obtain in any other way. (*De Revolutionibus*, Bk. I, Chap. X.)

"In the midst of all dwells the Sun." He postulated three motions of the Earth, (i) a diurnal rotation from west to east about the polar axis; (ii) an annual revolution about the Sun in the plane of the ecliptic; (iii) a variation in inclination of the Earth's axis to the line joining Sun and Earth. Thus he explained the apparent daily rotation of the heavens, the apparent annual motion of the Sun through the constellations of the Zodiac, and the cycle of the seasons. He discussed the motion of the moon as a satellite of the Earth. He dealt with the motions and relative positions of the two inner and three outer planets, explaining their siderial and synodic periods. He affirmed the extreme distance of all the stars, so great that the Earth's orbital motion produced no apparent parallactic shift of the stars. All this was elaborated with diagrams and position tables, and a weight of evidence so great as to leave no careful reader of *De Revolutionibus* with any vestige of doubt but that Copernicus intended his heliocentric planetary theory to be regarded as a statement of physical fact.

Small wonder, then, that when the far-reaching significance of this book was realized timid, bigoted and intolerant

ecclesiastics denied its implications and discouraged the study and discussion of its arguments by threat of torture and the stake. It was not, however, placed upon the Index until 1616, but there it remained until 1835.

William Gilbert in England and Giordano Bruno in Italy, both born in the 1540's, became the first notable men outside central Europe to convince themselves that a new light had dawned in astronomical thinking, and a new universe lay open to the eyes and minds of men. Gilbert advocated the Copernican theory and lived to publish his famous *De Magnete* and to die in 1603 respected and honoured in Elizabethan England. But Bruno's advocacy of the same theory placed his life in jeopardy. He escaped from Italy and proceeded to expound the Copernican cosmology and his own somewhat pantheistic but rather beautiful philosophy in Geneva but fled the intolerant disapproval of Calvinism. In Paris and later in Oxford and in Wittenberg he discoursed upon the new theory, being generally opposed but arousing interest in it wherever he went. Lured back to Italy on a promise of freedom to think and teach what he believed true, this scholarly disciple of Copernicus in science and of von Cues and Ramón Lull in philosophy went to the stake in Rome in 1560 for his advocacy of new ideas.

Sixty years later Galileo placed the Copernican Theory on so firm a footing of new astronomical observations that his name stands linked with those of Copernicus before him and Sir Isaac Newton following him at this great turning point in the history of human thought.

Thus Copernicus and his book ushered in the renaissance of learning in astronomical science. During the four hundred years which have followed, knowledge has grown from more to more. Copernicus had displaced the Earth from the centre of the Universe and man's abode had become a minor planet.

In a later century the Sun and planets were removed from a central position in the stellar universe to an inconspicuous place more than half way out along a radius of the Milky Way system. In our own century our galactic system has become only one of many million stellar galaxies. Circles gave place to Kepler's elliptic orbits three centuries ago. Nothing now remains static, neither earth nor sun nor stellar galaxy, not even the framework of space itself in the Lemaitrian speculations of our own times.

The repercussions of the Copernican cosmology upon philosophy were inevitably far reaching, though Copernicus himself seems not to have realized the full implications of his work in this respect. It was his great successor, Galileo, who boldly drew the inferences—if a geocentric cosmology had to be abandoned, anthropocentric philosophy must likewise go. Henceforth the man of science must investigate nature with complete objectivity. Philosophy must break away from the shackles of teleology focused upon man. Man was no longer obviously of prime importance as had been so easy to assert in the ancient world with its geocentric outlook. For man the sun and moon rose and set, for him the stars shone forth, for him the rains fell and the earth produced her increase—"Thou madest him to have dominion over the works of Thy hands, Thou hast put all things under his feet." If to-day man be regarded as of great intrinsic worth, it is not because this is an inevitable deduction from a survey of the physical universe, it must be for intellectual and spiritual reasons. Such reasons, happily, are not wanting when we study the character, achievements and influence of such men as Copernicus, men filled with courage and with "the divine afflatus of the truth-seeker".