

ASTRONOMY OF EARLY RENAISSANCE AND LEONARDO DA VINCI

Now that triumphant technology is about to land a terrestrial explorer on the moon, it is revealing to review the panorama of events half a millenium ago when such accomplishments were only fantasies of earthbound man. In this context we may most appropriately consider the universal genius of Leonardo da Vinci, « that finest flower of Renaissance », to use George Sarton's words. Modern space probes may therefore be regarded as only an extension of Leonardo's persistent dreams of the technique of flying, and Leonardo thus considered the pioneer of practical aviation. During the pregnant era of Leonardo's life, the course of the Renaissance more than ever prepared the ground for Copernicanism, which climaxed in the Galilean-Newtonian first scientific revolution. Fresh historical insight into that momentous era may shed deeper understanding of today's convulsive processes. These are enacted in the perplexities of man's present social life while, at the same time, the second scientific revolution builds its potential.

Leonardo was born into an age no less revolutionary than our own, 1452-1519. Besides several history-shaking developments of first magnitude, such as expanding oversea navigation, two portentous events occurred when Leonardo entered the world scene at Vinci in the middle of the flowering Italian Quattrocento — book printing and the fall of Constantinople. While these two events deeply affected the course of Western World history, it is characteristic of Leonardo's mind that they entered nowhere in the vast amount of creative notes he left unpublished to posterity. Nevertheless, he is the symbol of culminating Renaissance of the Quattrocento with Nicholas of Cusa as his forerunner in the first half of the fifteenth century. To visualize the processes of thought of the Leonardian world, we must first briefly consider the role of Nicholas of Cusa since Leonardo was definitely nourished by Cusanian ideas yet he rarely expressed them.

Cardinal Nicholas of Cusa represents an excellent transition between the Middle Ages and the Renaissance. Born at the beginning of the fifteenth century (1401-1464), the Ptolemaic world view was firmly established in Dantean cosmology, displaying in its time a rare and unusual understanding of « *Almagest* ». The majesty of the universe, closed in space and time, was divided into the corruptible sublunar region of four elements, and the incor-

ruptible, divine heavenly sphere. This divine sphere was made up of perfect unchangeable ether, utterly different from any earthly substance which, in this Aristotelian exposition, seemed to have been firmly established in the mind of the medieval scholastician. Immutable as the firmament on high indicates, it stood as the rock of ages with its hierarchical structure responding to the medieval anthropomorphic illusion. It required no lesser genius than Nicholas of Cusa to challenge this pleasing, man-centered cosmology that appealed to the scholastic theologians of the era.

Before becoming inspired by the well advanced currents of Italian Quattrocento, young Cusanus brought along with him the transalpine roots of the most promising aspects of Latin humanism, the Christian Renaissance, which radiated from Deventer and Zwolle in the second half of the fourteenth century. The school of the Brothers of Common Life at Deventer assured Cusanus ultimate leanings toward Neo-Platonic and metaphysical tradition that were to provide a rather strategic shield for his bold ideas in later years. The unusually progressive atmosphere of Paduan University and a significant encounter in Bologna with the great Florentine geographer, Paolo dal Pozzo Toscanelli (1397-1482), who encouraged Columbus to navigate westward, evidently left on the young monk distinct impressions that inspired Cusanus liberal views in the medieval framework. Toscanelli also became famous for his careful observation of comet 1456, later known as Halley's. Finally but not least important was Cusanus faithful Guelphian position which fortified the support and favor of the powerful papal curia. Accordingly, four years before Leonardo was born, Pope Nicholas V raised Cusanus to the cardinalship. These facts are only mentioned because they later safeguarded this «*Cardinalis teutonicus*» in his challenging reformist career in the mighty fortress of medievalism.

Our specific concern does not permit details of the evolution of Cusanian ideas such as weighing, measurement and experimentation as a way to detect natural laws. These ideas were equally radical when contrasted with the fossil attitude of the average scholastician. Our primary interest leads us to Cusanian cosmology. In this Cardinal Nicholas of Cusa challenged his contemporaries and successors to a shocking extent and, with the exception of Leonardo in the second half of the Quattrocento, he was opposed by all. A century and one-half later, however, he inspired the fiery disciple and reckless protagonist, Giordano Bruno. This radical new cosmology is exposed in Cusa's opus major with the curious title «*De docta ignorantia*», «*Of Learned Ignorance*»⁽¹⁾. Incidentally it was completed about the time the Council of Florence, in 1439, provided a unique opportunity for the meeting

(1) NICHOLAS OF CUSA, *De docta ignorantia*, Basle, 1565. English translation by Fr. Germain Heron, *Of Learned Ignorance by Nicholas Cusanus*, London, 1954.

of scholars from both Western and Byzantine Europe. Evidently due to the presence of Toscanelli, informal discussion of geographical questions was one of the natural by-products of this cosmopolitan gathering. This meeting alone may be considered the highlight of the Renaissance. In this context, let us not forget Amerigo Vespucci from a great Florentine family, who was destined to impress his name on the New World.

With bold criticism of the presumptuous science of astronomers and philosophers, « De docta ignorantia » reminds us of Kant's « Critique of Pure Reason » because it tries to differentiate between a noumenon and a phenomenon. It thus could be summed up as a means of transcending the limitation of our rational thought. With unprecedented audacity Cusanus denies the existence of privileged directions and places in the universe. He constantly returns to the consideration of an infinite universe and to the motion of the earth. According to Pierre Duhem, it appears that Thierry de Chartres is reflected in Cusa's Pythagorean fascination by the infinite in number and continuous subdivision. It is probably this mathematical infinity that leads him to the paradox that any « boundary » must divide one spatial region from another. Similarly, he ponders over the « beginning of Time » and the dilemma of « center » and states that since the infinite universe cannot have a « center », man is unable to conceive neither of these but God is all, the center, circumference and time. These were indeed radical statements from the medieval point of view in which Cusanus transferred to the universe the characterization of God as « a sphere of which the center is everywhere and circumference nowhere », thus liberating the universe from its hierarchical structure.

Another fundamental departure from homocentric Aristotelian orthodoxy was the doctrine of plurality of worlds, evidently a logical consequence of the Platonic principle of plenitude. It flourished in the late thirteenth and fourteenth centuries and thus was passed into the Italian Quattrocento. It is almost unbelievable to read the statement of the Medieval cardinal⁽²⁾:

« It is impossible for man to know whether the region of earth is more or less noble than another region of the universe... Perhaps the inhabitants of other stars are nobler than ourselves ».

It is truly astounding as we ponder these words which so well illustrate Quattrocento's rupture with the Middle Ages and its preparation for the era of Modern Science. Half a century later when Leonardo echoed Cusan ideas and advocated⁽³⁾: « Earth is not the centre of the circle of the sun, nor in the

(2) NICHOLAS OF CUSA, *Ibid*, Lib. II, Cap. 11-12.

(3) EDWARD MACCURDY, *The Notebooks of Leonardo da Vinci*. Reynal and Hitchcock, New York, N. Y., 1939, p. 281.

centre of the universe, earth is a star like the moon... » we are reminded of Meletus. He accused Socrates at the trial of regarding the sun and the moon as pieces of stone, not divine beings. Socrates replied that he merely quoted the views of Anaxagoras. This only indicates, as Pierre Duhem maintains, that in the history of any scientific doctrine there is no absolute beginning.

No Leonardian scholar to my knowledge emphatically denies the influence of Nicholas of Cusa on Leonardo. Cusanus died in Todi, Umbria, August 11, 1464, when Leonardo was twelve years old and about to enter Verrocchio's bottega or studio in Florence. Yet, the impact of Cusanian heritage was immediate in Quattrocento Italy. Even if Pio Emanuelli may be right when he doubts ⁽⁴⁾ that Leonardo ever read « *De docta ignorantia* », first published in 1489, the ideas of its content were in the air. Andrea del Verrocchio's studio was an important art and cultural center of Florence, a unique training school for Leonardo's temperament and the unfoldment of his universal genius. Besides, Cusanus ideas must have obtained proper airing even due to his high ecclesiastical position and his location in Italy. Verrocchio's studio was in a measure a spontaneous academy where in addition to art all new ideas were discussed during the frequent visits of a galaxy of distinguished contemporaries. Leonardo's unusually observant and intuitive mind found himself in the best surroundings. If he missed the regular training of the Latin schools of his time, which could have impaired his growth, he possessed remarkable sublimating ability in which he grasped sound judgment without being able to describe it in many words. That is why he was sometimes described as a man « *senza lettere* ». Like Nicholas of Cusa, Leonardo was also not a professional astronomer, yet his occasional notes or insight into the realm of the stars indicates that he was no stranger to some particular problems of astronomy.

Leonardo was drawn toward the Cusanian train of ideas because of his love for the measurable and like Cusanus he maintains ⁽⁵⁾:

« The man who discredits the supreme certainty of mathematics is feeding on confusion and can never silence the contradictions of sophistical sciences which lead to an eternal quackery ».

We seek Leonardo's view of mathematics because the history of astronomy cannot be studied apart from the history of mathematics or physics. One of the earliest biographers of the giant of Quattrocento, Vasari, commented in

⁽⁴⁾ PIO EMANUELLI, *Da Vinci's Astronomy*. Published in volume *Leonardo da Vinci*, Reynal & Company, New York, N. Y. and Istituto Geografico de Agostini. Novara, 1956, pp. 205-208.

⁽⁵⁾ ANTONINA VALLENTIN, *Leonardo da Vinci, Tragedy of Perfectionism*. Viking Press, New York, N. Y., 1938, p. 110. From Anatomical MSS, Windsor Castle Library.

1550 (*): « Leonardo never ceased to observe the sky, the course of the stars and the intrinsic qualities of living things ». Yet he quoted rarely the source of some statements, although he did no extensive reading with his knowledge of mostly self-taught Latin. This may be the reason for his lack of interest in book printing.

In Leonardo's scattered notes of his individualistic mirror writing we find a statement « Il sol no se muove ». It is not possible to read into it Leonardo's acceptance of the heliocentric system because elsewhere we find his adherence to the Ptolemaic scheme that was universal in his time. Yet Leonardo was first in the Western world to suggest the correct explanation of the earthshine that makes visible the entire disk of the moon while it is in the phase of the thin crescent. To have the moon illuminated by the light reflected from the earth was a serious disruption of Aristotelian dualistic illusion. Kepler's teacher, Maestlin, was the astronomer who returned to this phenomenon a century later, again with the correct explanation. With astronauts today circumnavigating the moon, such an explanation appears obvious. Yet, it is difficult to place ourselves into the inertial atmosphere of medieval prejudices and dogma concerning the corruptible sublunar region which, in this case, projects the reflected sunlight from the corruptible earth all the way to the moon. More than a century later even Galileo at times had to use cryptic language in order to announce a provocative scientific discovery which disturbed the scheme of peripatetic Weltanschauung. For many centuries earthshine had a popular explanation offered by Cleomedes as due to a certain transparency of the lunar globe. Even though this interpretation conflicted with the phenomenon of solar eclipse, it was still approved by Witelo as late as the thirteenth century.

Leonardo's cosmological views may be placed between those of Cusanus and Copernicus and, in some cases, because of Leonardo's natural nonconformism and bold rationalism even beyond Copernicus. Even if Leonardo never recorded his adherence to the heliocentric system, at least he abandoned the geocentric idea and defended the earth's spinning on its axis against classical objections. The mysterious note previously mentioned, « il sol non si muove », is from Leonardo's distressing Milanese period, when he worked on the Lord's Last Supper in Santa Maria delle Grazie and when the violent enthusiast Savonarola was burned at the stake in Florence. This was also the time that Copernicus, coming a great distance from what then was called Sarmatia, studied in Bologna under the influence of another early protagonist of the earth's motion, Domenico Maria Novara. These were days of danger and contradictions at the momentous divide of historical eras when

(*) GIORGIO DE SANTILLANA, *Man Without Letters*. Quoted from Morris Philipson's *Leonardo da Vinci, Aspects of the Renaissance Genius*, George Braziller, New York, N. Y., 1966, p. 203.

two intellectual giants at the cradle of modern science simultaneously moved through Italy, yet evidently without knowing each other. Leonardo's cosmological themes are subtle yet far-sighted and in his own advocacy of « learned ignorance » with which he was surrounded he was constantly encouraged to create a healing synthesis of seemingly senseless contraries. Vasari wrote in 1550⁽⁷⁾: « With the splendor of his mind, Leonardo brought refreshment to every downcast spirit », as he began to seek the nature of comprehension and perception while turning to those sources from which Cusanus had himself drawn. He sensed the eons of geological creation in his unprejudicial interpretation of the origin of fossils and from this unexpected angle shattered the mainstay of scholastic philosophy. As well stated by Santillana⁽⁸⁾:

« Leonardo discovers a universe in which everything is immanent physical clarity, where nothing is fixed or transcendental, where everything is force, life and movement: a universe ruled by a rigorous necessity and impassive justice, where the hidden harmony and coincidence of opposites subsumes good and evil in an ambivalent duality — a cosmos in which everything is beauty, a beauty which has never known itself ».

Leonardo will apparently remain inexhaustible. Just as many of his unfinished works of art, unpublished notes, so he will continue to be the source of new discoveries that were concealed in his fragmentary records. Literature on this mysterious giant of the Renaissance so far is immense. Every year from 1869 until 1920 a full sized book was published in Europe on this solitary life of what once was a humble birth to a peasant girl in a small stone cottage on the olive grown slope of Tuscany. Yet more than anyone else, Leonardo was destined to impress himself on the age of Renaissance and remain centuries ahead of our own age. His cosmology reveals his intense love of the thoughts he gathered. But he took the time nor did he care to organize them, leaving behind a vast amount of unpublished laconic notes. Therefore, explorers had to rediscover what Leonardo already knew and retrace paths he had trodden and mapped. Even today some few can possibly see farther because they stand on the shoulders of such seers as Leonardo da Vinci. He did not become rich, remaining a wandering, inefficient, homeless dreamer, exploited by scheming feudal lords. But, as George Sarton beautifully points out, on account of these « weaknesses » he became greater and closer to perfection than if he had been « efficient ». Sarton asks: « If a man is good and wise, why should he be efficient into the bargain? » Leonardo pursued the things which outlast time, the looming reality behind little realities, beauty and truth and a pure intent.

(7) ANTONINA VALLENTIN, *Ibid.*, p. 31.

(8) GIORGIO DE SANTILLANA, *Ibid.*, p. 202.