The World of Copernicus

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A thin pocketbook with yellowed pages, which I recall from my parents library in my childhood. The front cover with peeling plastics, shows a dark image of Copernicus as a magician, surrounded by excentric planetary orbits, against a dark blue background, turned purple with age and sprinkled with stars. I never read the book as a young man, but the haunting quality of its cover has been with me since then. Books are never thrown away, or at least should not be so treated, and decades later it has migrated into one of my own shelves. I cannot resist the temptation to read it.

It is not so easy to write a biography even of a man so well-known as Copernicus. The biographical sources have dried up, there are few letters surviving, and even those are to be considered as a miracle, and no contemporary has ever put down surviving documentations of the man. Yet Copernicus was not a child of obscurity. He was sent out to be educated, and although his parents died young, he benefited from the protection of an uncle, who was a bishop. Copernicus did his stints in universities of Germany and Italy[1] as well as in his native Cracow, and picked up many useful social skills, the largely rhetorical kind of medicine being not excepted. He spent a large part of his life in his uncles diocese of Ermland, close to the Baltic, and squezzed between the conflicting demands of the emerging Prussians, the Teutonic Knights and the Polish crown. Astronomy, not surprisingly, was his passion, although as most educated people at the time he was a jack of all trades, also writing incisively on matters economics and suggesting sound advice as to the subject of common currencies and the fighting of inflation. He was employed by the church and housed in a castle, where he lived in a tower, doing regular observations. His instruments were primitive, and he lacked the skill of a Tycho Brahe, yet according to the author, he was able to determine some vital astronomical statistics remarkably, not so say suspiciously, accurately. As to his major insight, that about placing the sun at the center of the planetary orbits, may have resulted from his reading of the ancients, in which the suggestion is to be found among the reports of the writings of Aristarchus. But he certainly elabourated on the idea, beyond those of the writers of antiquity.

One should keep in mind that the earth-centric models of Ptolemois were quite accurate as to the prediction of planetary movements. They were constrained by two rigid principles, in addition of everything revolving around the earth, movements could only follow circles, the most perfect of all movements, and thus the only possibilities for the

[1] The scholar was expected to be ambulatory, not to stick to one place, but to get influences from a wide variety. The author gives a few useful and suggestive glimpses from university life at the end of the 15th century. Teachers were requested to give a certain amount of lectures, and absences were frowned upon. Also they needed to maintain a minimal audience during their lectures, otherways, one surmises, pay was withdrawn. The life at a monastery probably supplied a more congenial atmosphere to an individual engaged in disintersted research that a university.

super-lunar world. The trick to make it work, in spite of what we now know are spurious constraints, was to introduce epicircles, which in the refined versions, became quite complicated with epi-circles on epi-circles[2]. Copernicus did away with the first, but not the second, so although his model was somewhat more simple, he still had to resort to a varieties of epicycles. One may wonder how to make a distinction between his theory and that of the classical, after all it was tempting to see his stratagem, as it incidentally was by the church at the time[3], merely as mathematical convenience. In modern Popperian jargong, a new theory should be subjected to attempts at falsification, and many of the predictions a heliocentric theory made, simply were not satisfied, the absence of parallax being the most damning. Copernicus countered that the stars were so distant that a parallex would be too small to be detected[4] Thus the success of the heliocentric view was more due to conceptual reasons than empirical verification (or failure to falsify). The true philosophical (and psychological) impact of the helio-centric world was not so much the displacement of man from the center of the universe, as the very idea that a center may not exist. It lead to ideas that the universe was of infinite extension, and that other celestial bodies may be the home of alternate civilizations, a act that was taken as granted by astronomers well into the 19th century[5]

> Observations of celestial bodies only give the direction of sight, not distance. The fact that the planets varied in brightness was to the ancients an indication that celestial bodies also varied in distance. For luminous bodies this brightness varied inversely with the square of the distance, for dark bodies reflecting lights, it is far more complicated, as one needs to take into account the objects distances to the source of the reflected light, as well as phase. The helio-centric point of view suggested a geometric way of actually determining the radii of the planetary orbits. For interior planets this is easy in view of determining their greatest separation from the sun. For exterior planets, the situation is a bit more complicated, and never explained in elementary book on the subject, although the astronomers at the time were quite adept at handling such matters[6]. Assume for simplicity that an outer planet moves in a circle with constant angular velocity. The orbital period of a planet can be determined through

[2] Incidentally adhering to a central mathematical technique, that of succesive approximations

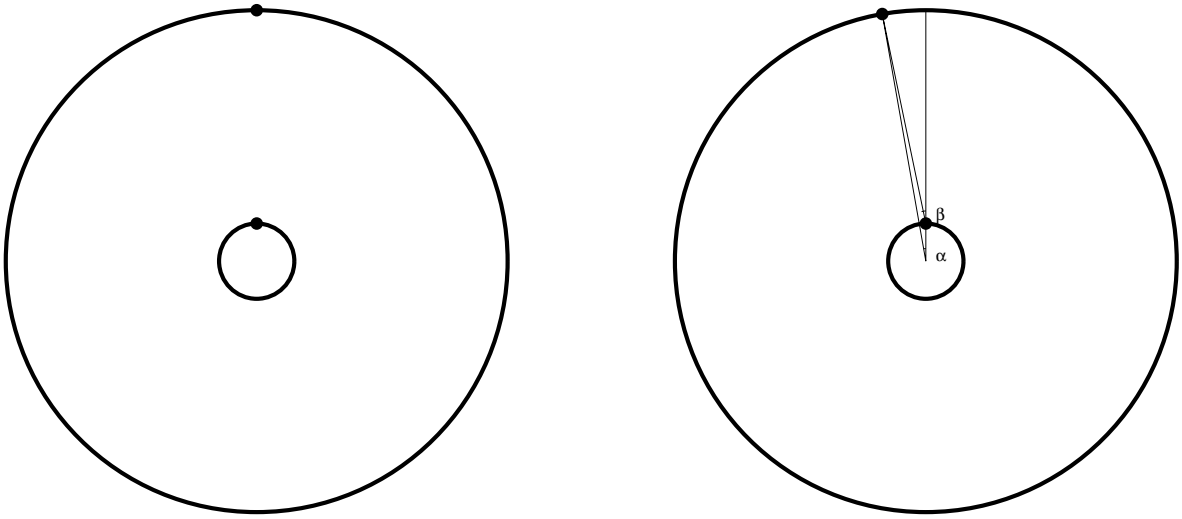
[3] The opposition of the Catholic church against the heliocentic worldview is legendary, but one should also remember that the opposition by the Protestants was even more virulent. The Catholic Church was after all corrupted, and corruption breeds tolerance, while the Protestants had an agenda and took the Bible very seriously, after all this was the very basis for their opposition to the Church. Consequently they had a tendency to read the Bible very literately. But finally one should also not forget that the spirit of Protestantism was after all protest and a questioning of worldy authority, and as such anticipating the Enlightment. Consequently many of the proponents of the New World View were protestants.

[4] It was believed since antiquity that the stars presented discs, thus either they were relatively close, would they be about the same size as the sun, or unbelievably large would they be as distant as Copernicus claimed. The ancient observers simply did not realise that the stars do not present any discs, the idea that they do is just an artefact of our visual system, that cannot conceive of light emenating from anything but a finitely extended source. In fact no telescope has of yet been able to magnify large enough to enable the disc of a non-solar star to emerge. In fact had they been able to accurately compare the luminosity of the sun with that of a star, they would have gotten a fair estimate of distance, as for all intents and purposes, the luminosity of a star is proprtional to the area of the disc it presents.

[5] Herschel is reported to have believed that the sun was populated.

[6] The history of ideas show that ideas are very important. As far as sophistication and intelligence are concerned, people of the past were just as clever and ingenious, as those of today (in general maybe even more so) And within their constraints they provided intricate technical solutions. An idea, as opposed to

a long sequence of observations and for simplicity let us assume that it is known. Then from the vantage point of two observations of the outer planet a year apart one can compare the predicted position of the planet (the angle α) from the observed (β) and from this discrepancy figure out by trigoinomettics, the radius of the planets orbit compared to that of the earth. This explains why the relative distances from the sun was fairly well-known by astronomers of the 16th century, but while it was much harder to find out absolute distances, involving a direct measurement of the astronomical unit, i.e. the distance from the Earth to the Sun.



Copernicus was not hounded down by the Church, this came in the beginning of the 17th century, with the burning of Bruno and the inquistional proceedings against Galileo[7] Eventually it carried the day, as true ideas inevitably do, although direct evidence for it was slow to emerge[8] This might partly been due to his low profile. He was very reluctant in publishing his findings, and they did appear only through the promptings of friends. He was presented by the printed book only on his deathbed, but by then he was already blind.

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a trick, essentially means a change of 'paradigm' seeing a problem from a new angle. While a trick as a stratagem, often very ingenious, is designed to push to the limits the prevailing 'paradigm'

[7] Who, by his telescopic observations, had provided strong circumstantial evidence of the Heliocentric view through the phases of the inner planets as well as the spectacle of the moons of Jupiter.

[8] Bradleys discovery of abberation in the end of the 17th century showed that at least with reference to the surrounding stars, the earth is orbiting the sun, while direct parallax was not measured until 1837. With Einsteins theory of relativity the situation was finally fully explained, systems not in uniform motion with respect to each other, do differ by their physical manifestations, thus one can make sense of one body moving around another, without any references to an absolute space or some conventional point of reference.