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Abstract

This paper seeks to find out the relationship between science and history by examining Tycho Brahe's astronomical account. It will be argued that Brahe could set up a new compromised system called neither the geocentric nor the heliocentric but the geo-heliocentric. The new system implies a reference that Brahe rejected both Aristotle' and Ptolemy' astronomical accounts from one side and Copernicus's account concerning new view of astronomy. In accordance with his religious beliefs, Tycho came to the conclusion that the Earth did not move, which meant that Copernicus had to be wrong. In consequence, Tycho conceived a new world system reconciling between both Aristotle and Copernicus.

This paper seeks to find out the reasons behind Brahe to reject both figures leading to a conclusion that Brahe had a philosophical position described as conventionalism.

Keywords:
Geo-heliocentric - Scientific Explanation-

Introduction:

This paper seeks to find a room for Tycho Brahe's system within Copernican revolution and to trace his scientific efforts towards establishing new picture of the universe. The reason to choose Brahe was that all achievements of heliocentric revolution were ascribed to either Copernicus or Galileo. What we are trying to do through this paper is to explore Brahe's scientific position and to what extent his scientific investigations led others to reinforce or to abandon his view. We will try to show that Brahe's astronomical system present a new picture of astronomy described as a reconciled picture derived from both geocentric view of Aristotle and heliocentric view of Copernicus. It was claimed that the astronomical observations that had been carried out by Brahe played a crucial role to form the new world view. It will be investigated here the reason behind Brahe leading him to establish a new astronomical picture contrasting both Ptolemy's and Copernicus's system. Finally Brahe's scientific effort will be assessed in its historical context.

Brahe was one of the most famous astronomers in the sixteenth and seventeenth century who got his fame from the accurate of his measurements and data he collected through his observations to celestial bodies. Brahe had new instruments and his famous observatory that was built by Frederic the second the king of Denmark which enabled him to collect accurate observations. These tools led him to criticize both Ptolemy and Copernicus for that experiments they had and the evidences they provided which were incompatibly to his own observations. In the light of his new findings, Brahe had to go beyond the apparent contradiction between his observations and theories of his predecessors. It will be argued here that Brahe established a new third account to reconcile between last two systems which was called by Brahe a geoheliocentric system:

This is not get the heliocentric system of Copernicus, rather it is often called the geoheliocentric system.(Halle,A.R.1983,P63)

What Brahe sought to do was to combine between these two systems and create new one that is called Tyhonic system or geo-heliocentric system where the earth is in rest and few planets revolve round its orbit, while five other planets revolve round the sun orbit.
Tycho advocated an alternative to the Ptolemaic geocentric system: A "geo-heliocentric" system now known as the Tychonic system, which he developed in the late 1570s. In such a system, the sun, moon, and stars circle a central Earth, while the five planets orbit the Sun. (Gingerich, O., 1977, P 78)

Figure(1) Shows Brahe's Model of Explanation

The question to be asked now, what are the reason behinds Brahe to create this reconciled system for explaining the celestial bodies and its movements.? It will be claimed here two reasons pushed Brahe to adjust this new compromised system. These reasons are the followings:

First reason was scientific one which indicates that Brahe's objections to Aristotle's and Copernicus's theories of the movement of the earth and the fixed sphere of the stars.

Second reason was religious one which indicates to role of scripture that was considered the main element that had been used by Brahe to attack Copernicus's heliocentric theory leading him to create a compromised system.

Brahe' Geo-heliocentric and Scientific Approach

It was true that the experimental atmosphere existed over Brahe's island let him to observe accurately the planets and other celestial bodies. Therefore it is ascribed to him the accuracy of his observations for the celestial bodies and the accuracy of data he collected through instruments he made. Therefore it is claimed that astronomy has been effectively changed after Brahe and the impacts he made for its progress. Before him, astronomers had no new accurate data and hence exact measurements, while after Brahe it was much easier to collect accurate data by the aid of new instruments leading him to achieve remarkable progress in the field of astronomy on his time.

Because of the number and variety of instruments made and described by Tycho, previous commentators have assumed that he made instruments for the sheer sake of keeping his instrument-makers busy. In fact, however, their construction can be traced in his logs and rationalized as several series of experiments which only produced his major instruments in the mid-1580's. The ten-year process had considerable consequences for progress of Tycho's theoretical work during his life. It has also obscured historical understanding of the accuracy of his instruments. (Thoren, V., 1990, P102)
Accordingly, Brahe could examine all hypotheses raised either by Aristotle, Ptolemy and Copernicus in respect to the observations and calculus he made. In the second half of the sixteenth century, Brahe observed a new star that appeared in the sky which attacked Aristotle's ideas about the unchangeable nature of the superluniary zone. Accordingly, Brahe gave new interpretation for this event in the light of his observation. He found himself to be forced to go beyond the Aristotelian view that was prevalent in the sixteenth century.

Tycho Brahe recognized a nove in the sky where the scholar for centuries had seen one because such phenomena were ruled out a priori by the reigning philosophy. (Cohen, H.F, 1994, P522)

According to Aristotle, he divided heavens into two spheres; sublunary zone that is the realm of generation and corruption and the superluniary zone that is the realm of unchangeable and eternity. It is common for astronomers before to believe that the comets do belong to the superluniary sphere. The reason for that was the creditability of Aristotle's physics which was absolutely accepted and irrefutable. On the other hand, Brahe could collect reliable data about comets through his new instruments led him to contradict Aristotle's themes. Brahe indicated that the new visitors were located in the superluniary sphere which led him to the conclusion that change is not restricted only to sublunary sphere but it is extended also to what Aristotle called superluniary sphere. This result led him to doubt about Aristotle's physics. Generation and corruption no longer takes place in terrestrial realm but also in celestial realm. This remarkable observation led Brahe to invoke the principle of peripatetic physics that was dominated in his time. However, in 1573 Brahe published his famous book De Nova Stella in which he strictly attached the old world view:

\[\text{He published De Nova Stella in 1573. The beliefs of ancient astronomy were being shaken to their very foundation.} (Goodman.D&Russell,C.A,1991.P77)\]

Figure (2) shows the Brahe's Geo-Heliocentric

It took time from Brahe to confirm his discovery in his book, the question why did he take all that time to confirm that change taken place in the celestial sphere?
Two reasons could present a plausible answer to that above mentioned question, first reason since he was busy collecting other experimental data from other European countries supporting his observation about the new visitor. This period of time encountered an intensive correspondences between Brahe and other European astronomers when they observed the new visitors. This reason gave an indication to his scientific thought and his methodological awareness. Second reason was the authority of Aristotle's physics dominating in the sixteenth century thought teaching. Therefore Brahe was very cautious to delay his new findings about the comets till he had proof supporting his view. In addition, Brahe, through his visits to European countries, gained a fame enabled him to declare his view with no fear from the authority of religious institutions.

The authority of Brahe as an observer was established by new, it became increasingly difficult to question his result which proved that the comets to be belonged to the celestial world and not to the sublunary one. This gave the lie to the immutability of world of the heavily bodies. (Fantolia, A, 1996, P31).

Now the questions needs to be asked, did Brahe entirely go beyond Aristotle's view or did he maintain some of his ideas? I disagree with some historian who claimed that Brahe's view implied some of Aristotelian views. They had evidences for their claim such as Brahe's scientific position. He was faithful enough to Aristotle to believe that the Earth is located in the center of the universe, accordingly, Brahe criticized Copernicus's system. However, I argue that we need to distinguish between to forms of authorities; the authority of Aristotle and the authority of the sacred scripture. What I will try to investigate here is the claim that Brahe could transcend the authority of Aristotle, but he still maintains the authority of the bible which has three evidences leading me to support that claim.

First evidence was methodological aspect that differentiated Brahe from Aristotle. In the sense that Aristotle's methodological view based on metaphysical and deductive background involved in his view of the universe, while Brahe applied different methodology depending on experiments through scientific observations. This approach taken by Brahe helped him not to fail in the circle ontological reductionism.

Second evidence if we analyze Brahe’s correspondences that had been sent to Caper Peucer, they could give us a keyword of Brahe's criticism to Aristotle and going behind his theories. This understanding leads us to the idea Brahe accepted the idea these changes did take place in the heavens. The theme that was postulated by Aristotle and Copernicus as well as ruined by Brahe's geohiocentric system.

It is crucial role is shown a letter to Casper Peucer, when he admits that the originality believed the heavens to filled with real spheres (Honahae, W.H, 1975, P255)  

Third evidence for this departure between Brahe and Aristotle was the claim concerning natural philosophy. It is claimed here that Brahe could successfully apply that natural philosophy to his cosmological views. This means that Brahe's system includes a religious dimension that buried his cosmological view and leading him to give a specific interpretation to his own scientific observations. Therefore, it is claimed that the reason behind Brahe to accept Aristotelian doctrine that the Earth is located in the center of the universe not the credibility and reliability of Aristotelian physics, but to defend and to respect the authority of the holy scripture:
He had some astronomical reasons for rejecting the motion of the earth, but a decisive influence was his literalistic intersection of some bible texts. (Open University, 1974, P72)

This religious dimension of Brahe's system will be illustrated later. Accordingly, it is found that one of the remarkable features of Brahe's discipline that there was an epistemological and cosmological break between him and Aristotle. Although he believed that Aristotle's physics is no longer valid to be applied and taken into the account of modern science, he adjusted Copernicus's cosmological views apart from his central theme concerning the statue of the earth. This simply a reference that Brahe's system implies a revolutionary aspect. The question to be asked what was the reason that prevent Brahe's system to be a revolutionary one comparing to those of Kepler and Galileo?

To answer the above mentioned question, it is necessary to discuss an important idea that was missed in Brahe's system. That was the deficiency of mathematical dimension comparing to Kepler for instance. It is indicated that Brahe has a lack of mathematical knowledge leading him not to set up a full unitary view of the universe. Although he was active and clever using scientific instruments to observe celestial bodies, but he could not find mathematical solutions for some problems comparing to Kepler. So it is claimed that Brahe was against Copernicus's system because he could not find mathematical solution for some of the theoretical themes raised by observations. Accordingly, I suggest that one of the main reasons for him to adopt his compromised system was his incapability of finding mathematical resolutions to some of the observations. However, this understanding does not let us to deny the fact that the observation made by him were potentially sort of revolutionary step leading some other astronomers such as Kepler and Galileo to achieve their experiments on the bases provided by Brahe:

Tycho Brahe's astronomical observations became a revolutionary factor in history only when the mathematical mind of Kepler had set to work upon that collection of mathematics. (Butterfield, 1965, P89)

It has been shown so far that if the scientific reason leading Brahe to adopt this compromised system could achieve a remarkable revolution in the universe. Then the question that had to be asked was, could religious reason play the same role within his own system? This question takes us to discuss the second part of our argument.

Brahe' Geo-heliocentric account and Religious Attitude:

I have shown earlier that Brahe's system implied a religious dimension forced him to adopt a compromised or reconciled system gathering between Aristotelian one and Copernican one instead of supporting and passing in the same stream run by Copernicus. It is claimed that Brahe's had a natural philosophical view involved in his cosmological system. Brahe's main goal was to reconcile between his observations to celestial bodies and the texts of the bible. Therefore, it is found that Brahe depended on the literal interpretation of the bible in contrast to Galileo who discard all the claims based on the literal interpretation of the apparent texts of the bible. This notice can be traced through his attempt to present a new interpretation of astronomy depending on his own reading to the old testimony. Therefore, it is important to put in our consideration this religious aspect when
we analyze Brahe's geoheliocentric theory. According to this understanding, we can comprehend Brahe's objections to Copernicus's theory of the movement of the Earth. In addition, this religious dimension can be followed through his correspondences with some astronomers which confirm how religious dimension to what extended formed his scientific view and understanding. There were two different correspondences reflect clearly that religious aspect of his scientific theory. The first one was in 1588 between Brahe and Cristoph Rothmann in which Brahe indicated that his cosmological views contained a religious aspect. Therefore, Brahe criticized the other systems on cosmos that ignore the importance of theology. In this reference he referred to Copernicus's new view on the universe:

Theology is more divine but less commonly used. This is indeed a knowledge of all ethics....It presents a physical consideration of created things.(Howell.K, 1988,P517).

This consideration gives us a note that Brahe opened a space for the religion to be displayed in his system and respectively in science. It can be deduced from that notice, Brahe made the circle of religion is more wider than astronomy itself. Accordingly, it can be said that the former implies the latter and vice versa. This understanding reflects the main motive behind Brahe to his attacks on Copernicus's central theme of heliocentrism and the movement of the Earth. Brahe indicated that:

In writing to Christoph Rothmann, a Copernican astronomer, Tycho used basic geometry to show that, assuming a small parallax that just escaped detection, the distance to the stars in the Copernican system would have to be 700 times greater than the distance from the sun to Saturn. Moreover, the only way the stars could be so distant and still appear the sizes they do in the sky would be if even average stars were gigantic — at least as big as the orbit of the Earth, and of course vastly larger than the sun. And, Tycho said, the more prominent stars would have to be even larger still. And what if the parallax was even smaller than anyone thought, so the stars were yet more distant? Then they would all have to be even larger still. (Blaire, A, 1990,P 376).

However, it is claimed here that Brahe had a potential readiness to accept Copernicus's theory and his deductions under one condition if it abandons the theme that the movement of the earth. We can grasp that meaning from the message which Brahe sent to Peucer in 1588. Brahe wrote the following:

For although Copernican theory conveniently remedies those other things which in the Ptolemaic system are incoherent and superfluous and it lacks nothing that is mathematically good, nevertheless, when it attributes a regular, perfect and by no means intricate motion to the earth. This assumption is rendered no less suspect, espically because it openly contradicts sacred Scripture in not a few places. (Howell.K, 1988,P517).

It can be inferred that Brahe restricts his system for the sake of religion to the extent that he could abandon Copernican scientific evidences brought up by accurate observations. The question to be asked now, what was the historical role of Brahe's theory played and functioned in the Sixteenth and the Seventeenth centuries. We are going here to discuss the importance of Brahe's system in the time encountered conflicts between the religious institution and the scientific institution. As it has shown before, Brahe's system implies two contradicted aspects. One aspect had been adopted by the Catholic church itself and the Jesuit astronomers such as Clavuis that defended scientific truths or facts supporting the verses of the bible. This team supports the literal meaning of the bible. On
the other hand, some liberal astronomers such as Galileo whom were against the literal interpretation of the bible. Respectively, they attacked Brahe's system for that particular reason. For the Jesuit astronomers, they had two central reasons to support Brahe's system. They sought refuge in his system particularly after the collapse of Aristotle's physics and Ptolemy's theories. In addition, they discard Copernicus's themes because of its discredit. The second reason to take Copernican theory was that Tycho Brahe's system maintained the biblical view concerning the rest of the earth. This led us to that suggestion the Jesuit astronomers adjusted his system because of his interest in the scripture and using his science to defend religious themes. The Jesuit astronomers adopted his system, who, by 1620, were making it their own for rejecting the full Copernican Scheme. (Brooke, J.H, 1991, P91).

Although Brahe set up his own account by the end of the Sixteenth century, the Jesuit astronomers adjusted his account twenty years after his death. It might be thought that they found out its credibility to defend some of religious themes emerged from Christianity they also used Brahe's views to attack Galileo's themes shaking the interpretations of the bible based on Aristotle's physics. In respect to that understanding, we find Clavuis and others who attacked Galileo using Brahe compromised account to display against Galileo's physics. Clavuis was cautious to give public support to the new cosmology of Tycho Brahe, although he had been aware of it at least since 1600. (Lindbery, D.C & Numbers, L.L, 1986, P95).

Therefore we could see the importance of Brahe's account to the church for its defense against liberal astronomers. On the other hand, there were a group of astronomers who believed in scientific investigations apart from any religious implications. These astronomers were Kepler and Galileo who were against the literal interpretations of the bible. As a result, they rejected some of Brahe's classical views on celestial bodies and its movements. For instance, Kepler stated that he prefers Copernicus's account than Tycho Brahe's account because of the mistakes implied in Brahe's account as he found out through his scientific investigations. In addition, Galileo had realized the same fact concerning Brahe's account because of it has been used by the religious authority represented in the catholic church to condemn other scientists. As a result, Galileo reached to that conclusion it was not Ptolemy's account that needed to be criticized but also Brahe's account.

Galileo was aware that the non-Copernican system that needed to be confronted was Tychoic not Ptolemaic. (Margolis, H. 1991, P273).

Now we reach to the last issue that will give a clear picture of the nature of Brahe's compromised system. It is claimed here that there is a gap implied in his system leading to this state of inconsistency. This inconsistent state can be summarized in the following, how possibly could Brahe described as a revolutionary in respect of his observation and experiments and at the same time described as a conservative individual who holds traditional view about the universe and the movement of the celestial bodies. How possibly could he an empiricist who believes in the existence of the observations and the importance of the experience, and in the same time be conservative who save the phenomena. This note can be captured through a correspondence he sent to Pecucer. In the light of that letter, his empiricism was clearly reflected by accepted the results.
came up through his observations as it is shown in his book De Nova and accepting the changes taken place in the superlunary sphere. This understanding shows that Brahe's system admits physical changes as real changes taking place in the nature. On the other hand, Brahe accepted other hypotheses as fictions has nothing to do with real changes. It is claimed here that he accepted the hypotheses provided by Copernicus concerning the movement of the earth as convention. He tried to avoid the truth of the theory as it was shown in his correspondence to Kepler published in 1602 the year he passed away:

*The arrangement which the great Copernicus attributed to the apparent rotations of the heavenly bodies is extremely ingenious and well adopted but it does not in reality, correspond to the truth.* (Duhem, P, 1969, P97).

![Figure(3) Shows Brahe's Intellectual Position](image)

In the following figure it indicates to the three criteria that formed Brahe's account on geohelico-centric view of the world are religion, intellectual dependency and finally science. In other words, the core of Brahe's theory of physics based on religion where it forms the real motive for his scientific research behind celestial phenomena. He sought to support the hly scripture and all what have been argued by the church. This step led Brahe to fall entirely on intellectual dependency. He could not free himself from the authority of both Aristotle and Potelmy from one side and the authority of the Fathers of the church and their teachings. Respectively, it is claimed that Brahe was not liberal enough to find his own way apart from such authorities and he did not use the Kantian rule "be dare to use your own reason" that is considered the main rule for the Enlightenment. Finally, this conservative approach reflected directly in Brahe's experiments and on his scientific explanations of the celestial phenomena. These three streams led Brahe to bring up scientific explanations that would be described as a conservative approach of analysis and scientific interpretation. It is something differing from Galileo's account who was against both intellectual
dependency and religious authority, that drove him to what is called a scientific revolution from one side and that may led him to be called as a revolutionary thinker and a scientist.

In the light of the previous understanding, we confirm that Brahe's aim was to save the phenomena. Although his intention was to save the phenomena, his system has a space for accepting the physical changes. If we sought to close the gap implied in his system and bring consistency back to his system, I suggest to admit that changes that take place in the celestial sphere as formal ones have nothing to do with reality. In the light of that view, we reinterpret the goal of his account was to save the phenomena. Without that suggestion, the gap and the inconsistency will be existed. Therefore it found that Brahe's account is unable to sort out this problem of apparent contradiction. This problem will be drastically solved by Galileo and Newton where their aim was not to save the phenomena but to admit changes proved by experiments.

Conclusion:
It is concluded that Tycho Brahe's system, called "Tychonic system" could make both epistemological and methodological shift from Aristotelian and Ptolemian physics. His compromised system did not seek to solve problems existed but to bring harmony between two different and contradicted astronomical world views. It is also concluded that Brahe 's system implied a form of natural philosophy to defend theological themes that shake by heliocentric account of the universe. Finally we tried to show that Brahe's system sought to save phenomena more than admitting the reality of the changes.

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