

The heliocentric science

[Science](#)



Samir Okasha showed in his book, “Philosophy of Science: A very short introduction”, what makes science a distinct body of knowledge which make use of “observations, experiments and theory-constructions” as can be reflected on the works of `De Revolutionibus` by Nicholaus Copernicus and `Letter to The Grand Duchess, Christina` by Gallileo. The works had been both controversial since they are against the normal view during their time. Okasha’s book is useful in understanding the concept of scientific revolutions, or the changes in scientific paradigm which can be reflected in the works of Galileo and Copernicus.

This essay would like to show how Okasha’s work can help in understanding the works of great scientists, specifically Copernicus and Gallileo. The essay would focus on the theme of scientific revolution. The essay would start with an introduction of science prior to the time of Copernicus and Galileo. The prevailing science and the role of religion would be highlighted to emphasize the difference between the roles of these two. The highlights of Copernicus’ work would be discussed. It will be followed by the defense made by Galileo against his retractors.

Finally, the concept of scientific revolution would be defined and the works of Copernicus and Galileo would be analyzed based on this context. Okasha explained that prior to the development of modern science that started during the 1500, science had largely been Aristotelian. This means that most of the things that are regarded as scientific are based upon the findings and writing of Aristotle. Aristotle was a Greek philosopher who studied several areas of knowledge including astronomy, physics, chemistry and biology. Particularly, he put forward that the earth is spherical and finite.

Aristotle believed that the movement of the planets is in circular motion. Aristotle also supports the notion that earthly bodies are composed of “ four elements: earth, water, air and fire”. Another important figure in pre-Copernican science was Ptolemy. The well-known geocentric model was set upon by this man before 170 AD. According to his model, the Earth is the center of the Solar System. Everything revolves around Earth. He used the concept of epicycles and equant to describe the movement of the planets and other heavenly bodies. Both Aristotle and Ptolemy hold that the Earth is stationary or does not move.

They believe that the heavens -the sun, the planets and the stars are the ones that move. Both also believe that the stars are fixed in the heavens. They imagined that there are shells that hold the heavenly bodies. Science, especially astronomy, had been based on these two thinkers for over 1000 years. Thus, knowledge had been highly dominated and is profoundly based on their ideas. Being able to survive from generations after generations and being unchallenged for more than 1000 years, it is only apparent that these sciences are considered as normal and at some point natural.

More particularly, Christianity as a religion gained authority which controlled or dictate knowledge based on their interpretation of the Holy Scriptures. Since the geocentric model is compatible with what is written in the Christian doctrines, it was considered as an absolute truth. During this period new discoveries would only be accepted if it does not contradict the Bible and if the evidences are too compelling that it cannot be disregarded by common sense. Nonetheless, no matter how perfect a normal science is -at first, anomalies would arise which produces doubt about normal science.

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There will be instances that run contrary to the accepted facts. At some point, these anomalies are treated as exceptions to the rule. However, as mentioned above, Okasha mentioned that one of the defining marks of science is the ability to construct theories which almost always generalizable. As anomalies builds up, the reliability of the theory weaken. New explanations are sought through experiments and observations. New theory is formulated which displace the previous theory. This process of change in accepted science is regarded as Scientific Revolution.

One of the most prevalent examples of this shift in scientific belief is the Copernican Revolution. This revolution happened shortly after Nicholas Copernicus published his work " De Revolutionibus". This work explicates the possibility that the sun is the center of the Solar System and not the earth. Copernicus tried to explain, at his best, the proof for this change in the model of the universe. Copernicus, himself, had been wary of publishing this discovery. It was not until he was sure about his explanation that he decided to publish his work. He received the first copy of his work before he died.

Since Copernicus served as a canon in Frauenburg, Copernicus undertook extreme caution not to upset the church with his discover. Thus, although he had his discoveries in 1515, he decided not to announce his views publicly. Instead he tried to gather more evidence and revised his work. The book consists of six volumes. The first part explained the heliocentric model and the reason why this is so. According to Copernicus, he decided to try the sun-centered model due to the massive contradictions and inconsistencies that he found in the Ptolemaic model.

The great number of anomalies involved calls for a new approach.

Copernicus explained that the Earth is not fixed or is not stationary. He described the movement of the planets on their axis. This movement, now known as rotation, denotes the movement of the sun and the heavens from east to west. Copernicus also acknowledges that the planets revolve around the sun. He identified the number of days before the known planets can complete one revolution around the sun. Furthermore, the Copernican model also explained the changes in seasons and the advent of eclipses.

In the later volumes, Copernicus tried to explain the movements of the other planets and he also explained the process on how he arrived to his conclusion. Since the book detailed explanation about the movement of the planets that are contrary to the literal meaning of the words in the Bible, it is expected that few people would consider and accept the idea. Removing Earth in the center of the universe seems to be a very strange idea that would overthrow the thought that God had made man as something special and that everything exists or was made for man.

Okasha cited that the book was “ banned in 1616 based on the assessment of the Catholic Church that the contents of the book contravene with those of the Holy Scriptures”. Copernicus had managed to gain popularity despite being criticized by the Catholic Church. Upon the invention of the telescope by Galileo Galilee, new evidences that support Copernicus findings arose. One of the critical observations made by Galileo was the presence and movement of sunspots. This discovery reiterated the fact that indeed heavenly bodies move in their axis or rotates.

As Galileo published his discoveries, he gained negative response and was even accused of being a heretic. To this end, he wrote the `Letter to The Grand Duchess, Christina` with the purpose of clearing his name. In this letter he explained his current situation and his findings. Galileo identified his retractors to include those who judge his work without reading and understanding its contents. Galileo stated that those who are against him are the people “ who has greater fondness to their opinions than truth”.

As it appears, this seems to be the case since those that accused Galileo as a heretic did so despite overwhelming evidence from Copernicus and from the findings of Galileo himself that indeed that is in the center of the Solar System. Galileo tried to clear his name by arguing that his retractors tried to show that his ideas are novel. It appears therefore that the action towards Galileo is a personal attack since previous authors or “ confirmer” such as Copernicus was not mentioned during discussion of his work.

He argued that Copernicus was not mentioned because his actions and findings were supported by the Catholic Church. To ensure that Copernicus book will be published, the preface was edited and it was explained that the book only reflects the hypothesis of a single man. Copernicus also addressed the pope in his book regarding the possibility that someone would “ dare to condemn and censure this hypothesis ... upon the authority of some scriptural passage twisted to their purpose (Galilei and Finocchiaro, 1989)”. Being accused as a heretic, Galileo argued that his findings are not contradictory to the Bible.

He explained that the words in the bible should not be taken literally. Galileo defended himself by making clear that the bible was made in a language and with the information that the masses or the common people can understand. For instance the higher mysteries such as the essence of God himself were described using human qualities and by referring to nature. Galileo elucidate the fact that the Bible did not necessarily discuss the heavens. The writers of the Bible only include those things that are necessary for people to live a “blessed life”.

Galileo summed this argument by citing a statement he heard from an ecclesiastic “the intentions of the Holy Ghost is to teach us how one goes to heaven, not how the heaven goes”. In the end, the heliocentric model is now accepted as the legitimate model of the solar system. This fact had been confirmed by several sense-experience evidences. The process whereby science changes from normal to revolutionary and back to normal science again is known as the Scientific Revolution. The process is continuous since everything known as science is fallible.

Although it is hard to think that there are other models of the solar system other than the heliocentric version, there had been several additions and further discoveries that might change the normal concept of the solar system. With respect to the idea of scientific revolutions, Okasha discussed the arguments put forward by Thomas Kuhn regarding the nature of scientific change. Kuhn coined the term paradigm to represent normal science. A paradigm is consists of “fundamental assumptions accepted by the scientific community and had solved theoretical problems with the aid of the fundamental assumptions (Okasha, 2002)”.

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The old paradigm are replaced ones anomalies, such as those mentioned above, exists continually. Scientist and thinkers would try to find a new way of explaining things by taking into account the corrections that must be made. The geocentric model had been accepted as true for more than 1000 years. Although there had been accounts and beliefs that the sun is at the center of the Solar System, they all remained as hypothetical assumptions. The work of Copernicus paved the way for an exposure of the anomalies while establishing a new paradigm.

Galileo succeeded in convincing the scientific community, through the use of his invention, to accept the new paradigm. With the aid of Okasha's book, one is able to get a better view of how the works of Copernicus and Galileo represent the concept of scientific revolutions. It also showed how resistance can affect the acceptance of new paradigm and how new sciences are produced. The process of revolution in the sciences does not take overnight but it takes decades or even centuries to develop.