Trombley, Tristin

Professor Marcello Bellini

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Abstract

This essay will address the topic of the Scientific Revolution during the 16th and 17th centuries and its significance. In particular, the discoveries and theories of Nicolaus Copernicus, Giordano Bruno, and Isaac Newton will be discussed. Sources were found via the course reader assigned to this class.

Introduction

During the 16th and 17th centuries, Europe experienced a radical change in scientific thought. The Scientific Revolution was the final expression of the Renaissance and was characterized by the development of the scientific method, abstract reasoning, quantitative thought, understanding nature as a machine, and ultimately replacing the former Greek view of how nature worked.

Born out of philosophy and new technology, science became an autonomous discipline. Many scientists, particularly Nicolaus Copernicus, Giordano Bruno, and Isaac Newton, combated the traditional ideals of the heavenly bodies and began to progress their theories about the universe. Eventually, a single set of physical laws were established that governed both the celestial and terrestrial realms. The image of God as a creator also shifted, and was thus defined as the divine architect, master mathematician, and clock maker that created the universe as a complex system. The Scientific Revolution set the stage for a new modern era.

Nicolaus Copernicus

Nicolaus Copernicus was born in 1473 in Toruń, Poland, where he became a polymath in astronomy and mathematics. He sought to find a solution that explained the erratic movements of planets using simple, clear, and elegant mathematical formulas. The science of astronomy was widely lacking in theoretical homogeneity and consistency at the time, and there were constant inquiries regarding the planets. Ancient assumptions about the solar system were maintained by Ptolemy's observations and prevented astronomers from accurately computing the movements of the heavenly bodies. Copernicus was rather technically proficient as an astronomer and a mathematician, which enabled him to recognize said inconsistencies of the existing cosmology.

He began to review ancient scientific literature which had previously become available due to the Humanist revival. His findings included several Greek philosophers, particularly of Pythagorean and Platonist views, who had already begun to propose that the Earth moved. However, none of the theories were developed enough to reach a full astronomical and mathematical conclusion.

Copernicus's hypothesis was that our universe was sun-centered with a planetary Earth, in which he calculated mathematically. His heliocentric model rationalized the daily appearance of the movement among the heavens as well as annual motion of the Sun because of the Earth's rotation on its axis and revolution around the Sun. It was then recognized that the appearances of the moving Sun and stars were created by the Earth's own movements. The reorganization of the order of the planets replaced the traditional Earth-centered order, and provided a simple solution to the ill-resolved problem of why Mercury and Venus always looked to be close to the Sun.

Commentariolus, one of the first versions of his thesis, was written in a manuscript and shared among Copernicus's friends around 1514. A lecture on the principles of his new system was given in Rome two decades later in front of the Pope, who had approved. A formal request to publish was made, however this was not necessarily a start to a revolution. The new concept was so contradictory to everyday experiences that it was viewed as obviously false and wasn't legitimately considered. However, as more and more proficient astronomers began to be persuaded by Copernicus's argument, religious implications of the new cosmology intensified.

At first, the Catholic Church was not in opposition, as Copernicus was in good standing with bishops, cardinals, and others within the Church. It wasn't until the Protestant movement had picked up traction during the Counter Reformation that Copernicus started facing religious consequences. In the eyes of the Protestants, tolerating or encouraging exploration of Greek

philosophy, science, and secular thinking contaminated the truth of the Bible. Many passages in Holy Scripture concerning the fixity of the Earth were contradicted by Copernicus's hypothesis, and his astronomy quickly became a threat to Protestants and was condemned. However, his theories continued on to influence future philosophers and scientists, who progressed his heliocentric ideas.

Giordano Bruno

Giordano Bruno was one of the first major philosophers to adopt the Copernican system. Born in 1548 in Nola, Italy, Bruno entered the Dominican order in Naples at the age of 18 and started to pursue theological studies. He also read literature of ancient philosophers and there began to doubt some of the teachings of the Catholic Church. His later acceptance of the Copernican system constituted a long series of philosophical and theological opinions that were alleged as blasphemy and in violation of the Church's discipline.

Giordano Bruno had accumulated an even more advanced version of a heliocentric theory than Copernicus, going beyond to identify an infinite universe. His first recognition of an infinite universe came from his establishment of form and matter, both of which the universe comprises. He then wrote a dialogue, *De l'infinito, universe e mondi,* in 1584, where he discussed the Copernican system of the universe and gave it philosophical meaning for the first time. He emphasized that the universe was infinite as a whole, and that it was not only a void beyond our planet. He also explained that the individual stars were subject to continual change through the influx and effluent of atoms, although they persist through either an internal or external force. He divided them into two groups: suns and earths, based on their either fire or water makeup. The assumption was also made that the various worlds outside were inhabited.

His radical theories had him tried and executed by the Inquisition. He was tried for heretical theological views that all religions and philosophies should coexist in tolerance and understanding, while the Bible should be followed for its moral teachings rather than its astronomy. Liberal and unorthodox views such as this were not welcome during the time of the Counter Reformation. He was burned at the stake in 1600 for various scandals.

Isaac Newton

Isaac Newton was born on Christmas day in 1643. He was an English physicist and mathematician that indulged in the work of Descartes and other philosophers while studying at Cambridge. While the Scientific Revolution was already well underway at this point, there were still many questions left unanswered: how did the planets, including the Earth, move at all? What kept them from flying out of orbit? Why did terrestrial objects always fall toward the surface? And more importantly, what was the structure of the universe and was there anything at its center? Newton achieved a synthesis of Descartes's mechanistic philosophy, Kepler's laws of planetary motion, and Galileo's laws of terrestrial motion in one comprehensive theory. It is considered that he completed the Copernican revolution and concluded the Scientific Revolution with his quantitative establishment of gravity as a universal force.

He developed the theory that gravity could simultaneously cause both the fall of stones to the Earth and the closed orbits of the planets around the Sun. His theories established that in order for celestial bodies to maintain their relative speeds and distances specified by Kepler's third law, the planets must have been pulled toward the Sun with an attractive force that decreased inversely as the square of the distance from the Sun. Conforming the same law were also bodies falling toward the Earth.

Newton's three laws of motion: inertia, force, and equal reaction, depict his combination of empirical and deductive rigor. The theory of universal gravitation established a physical basis for all of Kepler's laws, but was also able to derive the movements of the tides, the orbits of comets, the trajectory motion of projectiles, and the precession of the equinoxes. All of these ideas of celestial and terrestrial mechanics were unified under one set of physical laws by Newton. It was concluded that every particle of matter in the universe attracted every other particle with a force proportional to the product of their masses and inversely proportional to the square of the distance between them.

Although, Newton's working concept of gravity as a distantly active force seemed insufficiently mechanical to continental mechanistic philosophers. It puzzled Newton too, but through the concept of a quantitatively defined attractive force, he was able to integrate the two major themes of 17th century science: the mechanistic philosophy and the Pythagorean tradition. In fact, in 1686 and 1687, the Royal Society of London published Newton's *Principia Mathematica Philosophiae Naturalis*. It became a sensation of the modern mind, so much so that Voltaire called him the greatest man that ever lived.

Conclusion

The Scientific Revolution cultivated radical thought and scientific expression towards the end of the Renaissance. Thinkers like Copernicus, Bruno, and Newton developed the scientific method that we know today, using abstract reasoning and quantitative thought. They shifted the world's view of how nature worked by understanding the universe as a machine. Combating the traditional ideals of the heavenly bodies, they also began to change the perception of God as the sole creator to theories of complex and scientific systems ruling the beyond. This age brought the

mathematical foundations for understanding movement of celestial bodies, gravitational pull, heliocentrism, and the overall makeup of our universe. Their groundbreaking hypotheses have inspired a new modern age.