Theological conflicts between Galileo and the Catholic Church and their implications for modern disciplines

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Introduction

hristian apologists such as Henderson (1999) and Birkett (1996) argued that the conflict between Galileo and the Catholic Church is a battle between old science (Ptolemaic astronomy) and new science (Copernican astronomy), rather than a battle between science and religion. Bergman (1996) and Birkett (2000) pointed out that many Catholic clergymen were neutral to Galileo's theory and several Jesuit astronomers even endorsed Galileo's telescopic discoveries when he traveled to Rome in 1611. However, secular scientists who disagreed with Galileo and failed to defeat him took the dispute to the church. It is unfortunate that the Catholic Church was "used" by Galileo's enemies and since then the Christian religion has been misperceived as "an enemy of science." Clausen (2000) and Snow (1999) went even further to assert that not only does the Christian religion not hinder science from development, but also fundamental doctrines of Christian theology help the birth of modern science. On one hand it is unfair to merely view the tension between Galileo and the Catholic Church as a struggle between science and religion. On the other hand, it may be naive to blame secular scientists for the mistrial of Galileo and to de-emphasize the religious elements in this academic debate. Whitehead (1926) noted that "whatever suggests a cosmology, suggests a religion." (p. 141) No matter whether a cosmology is built upon astronomy, physics, mathematics, or speculation, it must carry certain assumptions relating to the inner structure of reality. Thus, the inquiry of cosmology inevitably steps into the realms of philosophy and religion. Besides the heliocentric worldview, which appears to contradict the literal interpretation of the Bible, Galileo's science contains certain elements that threaten the established theology of the Catholic Church. Therefore, the trial of Galileo could be viewed as a battle of old theology and new theology, as well as old science and new science.

Three major aspects of Catholic theology were challenged by Galileo's cosmology. First, the notions that Heaven and God are unalterable and that the universe is governed by static order were shaken by Galileo's unification between celestial and terrestrial mechanics. Second, mathematical reasoning, which plays a central role in Galileo's methodology, was in sharp contrast to divine revelation as the source of truth and the Church as the authority of judgment. Third, the importance of humans, which was affirmed by the geocentric worldview, was diminished by the heliocentric cosmology. The objectives of this article are to explain the first two of Galileo's notions and to discuss their implications to other disciplines.

Heaven and God are unchangeable

Aristotle asserted that the outermost sphere of the universe, which contains the divine element (Ether), is immutable. Aristotle's universe is composed of two worlds, namely, the supralunary and the sublunary spheres. These two regions are governed by two different sets of mechanics, which are known as celestial mechanics and terrestrial mechanics. In this cosmology, the world is hierarchically

ordered; everything belongs to a natural position. When something is attracted to a place where it belongs, the movement is considered a "natural motion." All other movements are considered "violent" or "unnatural" because they drive things away from their natural positions and thus disturb the cosmic equilibrium.
This philosophy had been tightly integrated into the Catholic theology for over a thousand years. In a Catholic's view, not only is heaven perfect and inalterable, but also the Creator of heaven is infallible and unchangeable. The Catholic Church has its own version of "two-sphere universe": On earth everything is changeable and perishable, but in the transcendental world where God, angels, and the saved souls reside, everything is everlasting. God as "being" instead of "becoming" has firmly established the foundation of truth. While "change" denotes decay, depreciation, decomposition, and many other negative concepts, the unchangeable God, revealed by the inalterable heaven and the hierarchically ordered world structure, gave people a sense of certainty and security, and a hope for the perfect world after death.

However, Galileo's discovery of sun spots, along with Brahe's observations of a nova, made the notion of an inalterable heaven questionable. In addition, Galileo abandoned the notion of a perfect cosmic order. To Galileo the heaven appeared as if God had scattered stars without any rule or pattern (Shapere, 1974). The strong opposition to Galileo could be partly explained by his threat to intellectual certainty and religious comfort. Further, since Galileo tore down the distinction between celestial mechanics and terrestrial mechanics by saying that heavenly bodies are as alterable as earthly objects, he stripped away the hope for a perfect world. To be specific, when the laws of heaven and the laws of earth are united, this implies that all considerations based on value, perfection, harmony, meaning, and purpose vanish (Koyre, 1943).

Although the preceding radical worldview pierces through the heart of traditional Catholic theology, modern science and theology benefit from this new perspective of "change." Since Galileo, "change" is no longer associated with negative connotations. Instead, "fluid," "dynamic," "growth," "progress," and other positive concepts are attributed to "change" in various disciplines, such as biology, economics and even theology. For example, based on observations during the voyage of Beagle, Charles Darwin boldly claimed that species do not always appear in the same way. Rather, they evolve through the process of natural selection. Interestingly enough, the classical school of economics embracing the view of market equilibrium highly resembles the Aristotelian philosophy. In classical economics, price, demand, and supply tend to seek the "natural position" and converge at equilibrium eventually. However, modern economics departs from the equilibrium doctrine and focuses on dynamic interactions among various economic factors. In theology, the school of Teilhard de Chardin (1965, 1971) and the Process Theology (Cobb & Griffin, 1976) also explicitly emphasize the vitality of change. In Teilhard de Chardin's view, truth is situational and revealed by God through the sign of generations. According to the Process Theology, God is no longer unchangeable, passionless, and absolute. Rather, God is passionate and thus He interacts with the world. It is not my intention to suggest that Galileo single-handedly changed the attitude towards "change" in Western civilization. Nevertheless, when Galileo rejected the Aristotelian view of static heaven and indirectly challenged the Catholic view of an unchangeable God, he introduced a new world order (or disorder) and opened many possible routes for scholars in later generations.

Mathematization of universe

Modern sciences are characterized by experimental methods. In this regard Galileo's and modern sciences bear little resemblance. Galileo was interested in "thought experiments," but not actual experiments. He regarded experiments as devices by which to convince his rivals instead of research tools (Westfall, 1977). There is a widespread myth that Galileo conducted an experiment at the Tower of Pisa to disprove that heavy objects fall faster than light objects. Indeed, Galileo argued against the preceding faulty belief by logical reasoning instead of performing the alleged experiment (Kuhn, 1957). It is a well-known fact that Galileo presented his astronomical theory with the substantiation of empirical (telescopic) observations. However, it is important to note that uncontrolled observations are not the same as controlled experiments. On the contrary, naive observations and common sense are obstacles to scientific discoveries.
Actually, mathematical thinking plays a more important role in the construction of Galileo's astronomical model. It is true that Galileo's methodology led to modern science. But that is quantiative methodology rather than experimental methodology (Carnap, 1995). Galileo emphasized that mathematics is inseparable from philosophy, just like medicine is tightly integrated with science (Reston, 1994). In Galileo's view, mathematics is the language that we must use to speak to nature and receive her answers (Koyre, 1943). Mathematization of the universe is supported by his belief that God reveals himself not only in the wonder of nature, but also in our human mind. In terms of scope, human knowledge can never be compared with the extensive divine wisdom. However, in regard to intensity, the human mind, which is equipped with mathematical knowledge, coincides with the divine wisdom. The only difference between the two minds is a matter of time, because the knowledge gradually attained by the contemplating human mind is always omnipresent in the mind of God. Galileo used astronomy as a metaphor in epistemology. In his framework, the human mind is a subset of the divine mind, just as the solar system is a part of the universe. In short, Galileo was convinced of the divine character of human intelligence (Olschki, 1943).

No doubt the preceding notion was unwelcome to both Catholics and Protestants. For Catholics the source of knowledge is the divine revelation rather than human endeavor. Although the "five ways" of proving the existence of God proposed by St. Thomas Aquinas are rational approaches, all five arguments are based on divine manifestation. Under Anselm's premise that faith precedes reason, knowledge is a supernatural gift of grace and truth is all that God has revealed because he has revealed it. The role of our rational human mind is simply to accept the revelation rather than to explore the uncharted water.

More importantly, the Catholic Church regards herself as the authority and guidance of truth. In the Catholic tradition, it is inconceivable for individuals to approach the divine mind on their own. In a similar vein, Lutherans who regard the Bible as the sole foundation of truth (Sola Scriptura) could hardly accept Galileo's notion. Not surprisingly, Galileo's assertion is also considered heretic by Calvinists, because in the Calvinist theology, every aspect of the world, including our human intellect, was corrupted after the spiritual fall of Adam and Eve.

Galileo's ideas help to shape the quantitative character and the exploratory spirit of modern disciplines. Empirical-based methodologies might lead to technological advancement, but empirical observations alone could not result in the rise of modern science. As Carnap (1952) said, empirical observations might lead to the generalization of empirical laws, but not theoretical laws. For instance, even if an inquirer observes thousands of stones, trees and flowers, the inquirer could never discover physical, chemical and biological laws in the atomic level or the molecular level. Through the mathematization of universe, researchers are able to analyze the observed data in an abstract and insightful manner. As

mentioned before, Galileo observed that the universe appears to happen by chance, and hence he developed advanced mathematics in an attempt to explain the phenomenon. Similarly, statisticians such as Fisher (1934, 1956), Neyman and Pearson (1933) take randomness into account to build the methodologies of significance testing and hypothesis testing. By the same token, psychologists, physicists, petroleum engineers, and market researchers apply the chaos theory to extract patterns out of random and even chaotic phenomena (Gleick, 1987; Peters, 1994; Robertson, 1995).

The assertion that the human mind is comparable to the divine mind turns the human intellect from a passive and receptive role to an active and exploratory one. Galileo is not alone. As a supplement to deduction and induction, American philosopher Peirce (1934/1960) introduced the logic of abduction as a mode of inquiry. Like Galileo, Peirce boldly asserted that in abduction the inquirer employs creative thinking, which resembles the mind of God. Based on the Peircean abductive logic, Yu (1994) introduced the logic of exploratory data analysis to provide a framework for quantitative research. This exploratory character can also be found in many other modern schools of thought. Without physical and intellectual explorations in the last four hundred years, human sciences and technologies might not have reached such a high level.

Conclusion

The conflict between Galileo and the Catholic Church is indeed religious and theological in essence. Since Galileo destabilized the beliefs of the immutable heaven, the unchangeable God, and the hierarchically structured universe, the positive concept of "change" has been quietly revolutionizing various disciplines. Moreover, it was the mathematization of the universe, instead of empirical observations or experiments, that brought a new meaning to science. The divine and exploratory character of the human intellect, which is derived from the mathematization of the universe, liberated the human intellect from confinement by restrictive doctrines, such as the spiritual distortion of the human mind (Calvinists), the Bible as the sole source of truth (Lutherans), and the divine authority of the Church (Catholics).

In spite of the aforementioned ideological conflicts, one should not jump to the conclusion that Christian religion is anti-science or anti-intellectual. Even while facing oppression by the Catholic Church, Galileo never gave up his Christian faith (Sobel, 1999). Indeed, Galileo found no incompatibility between his faith and his cosmology. Besides scientists, theologians such as Teilhard de Chardin, Hans Kung, Paul Tillich, and Karl Barth are also condemned by conservative Christians. As mentioned in the beginning, the case of Galileo could be viewed as a struggle between old theology and new theology. Although Galileo is a scientist rather than a theologian, his cosmology and methodology carry theological attributes and make him the Teilhard de Chardin and Hans Kung of the seventeenth century.

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