

# A comparison of Korean and Japanese Scholars' Attitudes Toward Newtonian Mechanics<sup>1)</sup>

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## 1. Introduction

In nations of East Asia, western science, particularly modern science, has been considered as an essential prerequisite for their processes of modernization. Therefore, those who embraced and argued for the acceptance of facts and theories of western science have been considered pathfinders in their countries and have received much scholarly and popular attention. On the other hand, those who resisted western science or struggled to defend traditional knowledge of nature have been labeled conservative. For example, Korean scholars who accepted the earth's rotation, such as Kim Seokmun 金錫文(1658-1735), Yi Ig (1681-1763), Hong Daeyong 洪大容(1731-1783), and Choe Hangi (1803-1877), have received much attention. Likewise, early Japanese advocates of heliocentric world system, Motoki Ryoe 本木良永(1735-1744), Shiba Kokan 司馬江漢(1749-1818) and Shizuki Tadao 志筑忠雄(1760-1806), have received much scholarly attention and become objects of research.

Western science in premodern East Asia, however, was context-dependent knowledge. Instead of understanding it in its own western context, intellectuals of premodern East Asia reinterpreted western science according to their own intellectual tradition and natural philosophy. Therefore, before asking how early and how much an East Asian intellectual accepted western science, we must discover how it was understood in the East Asian context and what meaning was granted to it.

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1) For the entire version of this paper, please see Jun, Yong Hoon, "A Comparison of Korean and Japanese Scholars' Attitudes toward Newtonian Science," *The Review of Korean Studies*, vol. 13, no.1 (2010).

Intellectuals of pre-modern East Asia often gave new interpretations to western science and used elements of western science as ingredients of their own ingenious thinking and arguments. In particular, Choe Hangi 崔漢綺(1803~1877) of Korea and Shizuki Tadao 志筑忠雄(1760-1806) of Japan even interpreted and reinterpreted “universal” Newtonian celestial mechanics according to their own intellectual contexts. Using the traditional East Asian concept of “gi 氣” as the base concept, the two men reinterpreted concepts of Newtonian science and developed new and original thoughts in their natural philosophies.

In this paper, I will focus on the concept of gi, which had been used as a key concept in East Asian natural philosophy and with which the two intellectuals commonly engaged when they interpreted western science. I also focus on how the two intellectuals from Korea and Japan, respectively, perceived the concept of gravity, a key concept of the Newtonian mechanics. The similarities and differences will be seen from the strategies the two intellectuals employed when they evaluated Newtonian mechanics which concentrates only on mathematical descriptions of physical phenomena, neglecting the explanation of the origin of gravity and the physical mechanism of gravitational interaction. Lastly, the two intellectuals’ assessment of the concept of a supernatural God, the creator and authorizer of the universal order in the Newtonian science, will be compared.

## 2. Meeting Newtonian Science

### 2.1 The case of Choe Hangi

John Herschel’s (1792-1871) *Outlines of Astronomy* (4th edition, London, 1851) was translated and published in Chinese under the title *Tantian 談天* in 1859. This text was translated by British Protestant missionary Alexander Wylie (1815-1887) and Chinese mathematician Li Shanlan 李善蘭 (1811-1882). John Herschel’s book is said to have combined the nebulae astronomy and Newtonian celestial mechanics. *Outlines of Astronomy*, in particular, was recognized as a successful accomplishment in this regard.

It is likely that the first Korean who read *Tantian* was Choe Hangi 崔漢綺 (1803~1877). Based on the scientific knowledge garnered from this book, Choe Hangi expressed his own ingenious thoughts in his *Seonggi unhwa 星氣運化* (Dynamic Change

of Stellar Gi, 1867). Through this text, it is possible to discover how a Korean Confucian scholar engaged and responded to Newtonian mechanics.

## 2.2 In the case of Shizuki Tadao

Shizuki Tadao 志筑忠雄(1760-1806) became a Dutch interpreter in Nagasaki 長崎. However, Shizuki quit his job in a year and focused on researching and translating Dutch texts. He later became a great authority on the so-called Rangaku 蘭学 (“Dutch studies”), extensively researching and writing on western geography, astronomy, mathematics and physics. Among 40 books written by Shizuki, Kyūryokuhōron 求力法論 and Rekishō Shinsho 曆象新書 are representative ones that mainly touch upon Newtonian science.

Kyūryokuhōron and Rekishō Shinsho are based on the Latin writings of John Keil (1671-1721), an Oxford University professor in astronomy and avid advocate of Newtonian natural philosophy. Johan Lulofs (1711-1768), a Leiden University professor in astronomy, collected and edited John Keil's works into a single volume and added annotations. Lulofs published it with the title *Inleidinge tot de waare Natuur-en Sterrekunde, of de Natuur-en Sterrekundige Lessen van den heer Johan Keill, M.D.* (it has been referred to as the *Collected Works of John Keil* 奇児全書 in Japan) in 1741. The *Collected Works of John Keil* is generally understood as a prime textbook of orthodox Newtonian science of the Great Britain and the Netherlands.

Through the *Collected Works of John Keil*, Shizuki Tadao became the first Japanese to be introduced to orthodox Newtonian science. Shizuki focused on the learning of Newtonian science, as well as translation, for the 20 years until 1802, when he completed *Rekishō Shinsho*. Glancing at the additions he made to the translation of Keil's text, it is clear that Shizuki was more than a faithful translator of Newtonian science. He was a natural philosopher in his own right, who sought to convey his own vision of nature and humanity via Newtonian science.

## 2.3 Characteristics of Newtonian Science

Science in eighteenth- and nineteenth-century Europe that, in particular, shared Newton's methodologies and worldview is generally referred to as Newtonian science. One of the most salient aspects of Newtonian science can be seen from his quote, “I do not make hypotheses.” Believing that there is no evidence that can induce or deduce the origin and mechanisms of action at a distance, Newton argued that all explanations

of action at a distance are merely unscientific hypotheses. Newton argued that, even without understanding the origin or the physics of gravity, he was satisfied with merely being able to generalize the existence of gravity and explain the motions of the earth and the universe. However, the reason both Choe Hangi and Shizuki Tadao were dissatisfied with Newtonian science was precisely because it lacked an explanation of the origin and physics of gravity.

Newtonian science acknowledged the concept of supranatural and omnipotent God in order to establish the appropriateness and purpose of the existence of nature and man. Newton believed that the universe was created by God's divine will, and therefore all must obey his rule. The Newtonian perspective recognizes that God, the ruler of nature, sometimes intervenes in the workings of nature.

Choe Hangi and Shizuki Tadao drew opposite conclusions on the question of a supranatural God. Although discontented with Newtonian science's unwillingness to explain the origin of gravity, Shizuki Tadao nevertheless accepted Newtonian science's perspective on God by recognizing the gravity's inconceivability. On the other hand, however, Choe Hangi did not recognize the existence of God and established his own philosophy and mechanics.

### 3. Choe Hangi and Newtonian Science

#### 3.1 *Gihak* 氣學: Physical Substratum and Vital Activity

Choe Hangi's thoughts on Newtonian mechanics was based on his *gihak* 氣學 (the study of *gi*), developed even before his reading of John Herschel's work. *Gihak* is a system of thought that seeks to explain all phenomena of the universe using only the principle and mechanism of *gi*.

Choe Hangi believed that *gi* has two fundamental principles: "physical substratum 形質" and "vital activity 活動." To use the modern rendition of his words, "*gi* physically exists because of its physical substratum, and it can be intelligibly recognized." In addition, due to its constant movement, *gi* always gives off life energy and forces matter in the universe to move.

Choe's fundamental concepts, "physical substratum" and "vital activity," can

be read as equivalents to Descartes' "matter" and "motion." From this, surprising parallels can be observed between Choe Hangi and Descartes. Choe Hangi's thought substitutes Descartes' "matter" with "gi with physical substratum" and "motion" with "gi's vital activity." In addition, the two men are similar in this sense that Choe Hangi seeks to explain the conveyance of strength and movement via "revolving gi" while Descartes did the same via the "vortices" of matter. The two men were also critical of the concept of gravity in Newtonian physics. They both considered it unreasonable that Newtonian physics fail to explain the origin and mechanism of gravity while positing gravity as a major premise of natural philosophy. While Choe Hangi never knew of Descartes' works, striking parallels came about as the two men sought to develop their respective philosophies based on the two (similar) fundamental concepts.

It is also important to note the difference between the two philosophies. In particular, they stand in conflict on the existence of God. While Descartes posits God as the first and only "unmoved mover," Choe Hangi sees the two principles of *gi* to be innate. According to Choe, everything in the universe was created from *gi*. In this scheme, there was no place for the creator or the "unmoved mover."

### 3.2 Replacing Newtonian Celestial Mechanics with the Mechanics of *Gi*

Newtonian science is satisfied with mathematical descriptions without delving into the origin or physical mechanisms of gravity. For the philosophy of *gi*, which seeks to explain all phenomena using the principles of *gi*, that tendency of Newtonian science is obviously an object of criticism. Choe Hangi responded to Herschel's text by saying that Herschel's work is a mere description of "what has already appeared 已然之跡."

*Gihak* aims to explain all natural phenomena using the basic principles of *gi*. Therefore, from the perspective of *gihak*, the origin and physical mechanisms of gravity must be explained prior to its description. That is the reason why Choe Hangi introduced *gi* here. Choe argues, "Force come from *gi* and immediately applies itself." (Choe 1834b:30d) Choe Hangi believed that *gi* was involved as

the origin and medium of gravitational action.

Choe Hangi defined gravity as “the force of earthly qi 地氣 pressing down.” (Choe 1867:125b) As mentioned above, Choe Hangi believed that *gi* was the origin of gravity. Furthermore, Choe also contended that the physical mechanism of gravity is predicated upon the downward pressure of *gi*. From Choe’s perspective, the downward force of *gi* was already proven by the Torricellian experiment outlined in western science books.

Choe believed that all phenomena already explained by Newtonian mechanics, such as the rotation and revolution of the earth, the earth’s spherical shape, and how people standing in the antipodes can stand up straight, can be explained by his theory of *gi* (Choe 1860:78a). Choe argued, “When the *gi* around the earth rotates, it encloses the *gi* inside by building a shell. This is the reason why the earth turns out to be spherical in its shape.” (Choe 1860:75d) From Choe’s perspective, the inherent rotation of *gi* above the earth’s surface causes downward force (pressure), and that downward force causes gravity. Everything could now be explained via the movements of *gi*. For Choe Hangi, fully convinced of the rationality and applicability of *gi* mechanics, descriptive Newtonian mechanics, which had no explanation of the origin and physical mechanism of gravity, was merely “a conjectural opinion 揣摩之見.” (Choe 1867:179a)

On the celestial mechanics Choe Hangi also presented the agency of *gi*. In order to present his theories as applicable in the celestial world, Choe Hangi invented the concepts of “*gi* globe 氣輪” and “the forces of attraction and repulsion 牽引推拒之力” that the *gi* globe drives. As to the “*gi* globe” concept, Choe Hangi believed that all elements existing in the universe were surrounded by *gi*, and the movements of *gi* surrounding them brought out certain phenomena and caused us to recognize it. As mentioned above, the earth itself also has an atmosphere surrounding it that causes a downward force toward the center. By collecting the atmosphere of the celestial bodies, Choe Hangi concluded that all elements in the universe, including the earth itself, are always surrounded by the “*gi* globe.”

On “the forces of attraction and repulsion,” Choe argued that, “*gi* has two fundamental properties. One is attraction and combination, and the other is repulsion and refusal.” (Choe 1866:455d) Choe also believed that “the forces of attraction and repulsion” were proven by the already-conducted experiments of western science. The phenomena of electricity and magnetism were typical examples (Choe 1866:468b). Then Choe became convinced that a “*gi* globe” activates the forces of “attraction” and “repulsion,” the essential properties of *gi*.

Substituting the forces of “attraction” and “repulsion” of a “*gi* globe” in place of the Newtonian concept of gravity, all mechanical actions explained by the Newtonian science could be explained by the mechanics of *gi*. For Choe Hangi, the origin of gravity that Newtonian science did not explain was explained by the fundamental properties of *gi*. All gravitational phenomena, including the orbital motions, occurring between different celestial bodies were caused by applications of the forces of “attraction” and “repulsion.” Choe Hangi argued, “As a result of the attraction by one body and repulsion by the other, orbital rotation is achieved.” (Choe 1867:120b) “Were it not for *gi* globes, on what ground could the second and third bodies at distance attain attractive and repulsive action?” (Choe 1867:179d) At this point, the Newtonian science, which does not explain the origin and physical mechanisms of gravity, became an incomplete theory that lacks a full understanding of the fundamental properties of *gi*.

### 3.3 Dynamics to Ethics

The purpose of scientific study in Newtonian science was to read God’s divine will from natural phenomena and obey it. In Newtonian science, God was the reason behind the existence of man and nature. The appropriateness of man and nature also comes from God the creator. On the other hand, the purpose of Choe Hangi’s *gihak* is to find the ultimate principles of *gi* and follow and participate in the movement of *gi* in the universe. In addition, as the *gihak* does not recognize the concept of supranatural God, the appropriateness and purpose of man’s existence also does not come from God. As all things in the universe

are created and changed by the movements of *gi*, the purpose also comes from the *gi*. “Successive following 承順” is the ethical concept that Choe Hangi suggested to deduce the purpose of the existence of man and nature from *gi*.

As already mentioned, according to Choe Hangi’s *gihak*, everything that exists is surrounded by a “gi globe.” One “gi globe” intersects with the others, creating an infinite chain of intersections in the universe. Therefore, everything in existence in the universe participates in the movement of the universe. There is not a single entity in the universe that stands on its own without interacting with other something else in existence. Satellites are interconnected with the planets, the planets are interconnected with the solar systems, and the solar systems are interconnected with the movements of the entire universe. Likewise, movements of individual people are interconnected with the small groups they belongs to; the movements of small groups are interconnected with the movements of large groups; the movements of large groups are interconnected with the movements of states; and the movements of states are interconnected with the movements of the world. The movements of the world are interconnected with the movements of the earth, and the movements of the earth are interconnected with the movements of the solar system. Choe Hangi therefore believed that everything in existence in the universe is interconnected with existent smaller mechanical structures as well as larger mechanical structures.

Everything in existence in the universe “succeeds 承” and “follows 順” according to their place in the hierarchical structure of movements. That is why it is most upright and ethical to “succeed” and “follow” according to one’s place within the mechanical structure. Therefore, attempts at crossing or leaving the structure are immoral. As human beings are part of the infinite chain of “gi globe” interconnections, the only right and moral thing to do is to abide by the structural order. The principles of ethics and morality, therefore, can be ascertained by learning about the physical mechanisms of “gi globe” interactions and following them. Choe Hangi deduced the grounds of human morality and ethics via the movements of “gi globes” and the mechanics of *gi*, without ever having to refer to a supranatural God.



## 4. Shizuki Tadao and Newtonian Science

### 4.1 The Eye to See Newtonian Science: *Gi*

Unlike Choe Hangi, Shizuki Tadao did not have a philosophy of his own when he first learned about Newtonian science. However, Shizuki was nevertheless influenced by the universalism of *gi*, a perspective shared in premodern East Asia. The *gi* cosmology was widespread in East Asia since ancient times, in which *gi* was recognized as a fundamental element of the universe. Shizuki considered or translated the immaterial and fluid elements discussed in the *Collected Works of John Keil* as *gi*.

Shizuki Tadao, in particular, used the *gi* concept in interpreting Newtonian theories on matter and particles. (Yoshida 1972:391) Newtonian science, as was believed by John Keil, saw that all matter was made of particles (*particula*). Shizuki argued that *gi* forms if indivisible particles gather together. As already proposed by the theories of *gi*, it was obvious to Shizuki that a gathering of *gi* turns into material. Shizuki Tadao argued that “*gi* is made of a gathering of quality 質,” (Shizuki 1802:72) and quality here refers to the fundamental properties of a kind of matter that a particle retains.

Due to his usage of *gi* theory in interpreting Newtonian concepts, Shizuki pursued his research from a different perspective and came up with results which differed from Newtonian concepts in two ways. For example, although Newtonian science argues that the space is empty 眞空, Shizuki Tadao disagreed and argued that it is filled with *gi*. As mentioned before, Newtonian science did not attempt to discover the origin of gravity. Shizuki Tadao, however, sought to find an answer and guessed that gravity originated from *gi* and was conveyed by it.

Although Newtonian science proposes a vacuum space where elemental particles exist, Shizuki Tadao's reinterpretation of the theories and facts of Newtonian science led him to believe that a vacuum cannot exist due to the omnipresence of *gi* (Yoshida 1972:388). Among the theories of Newtonian science, particularly important to Shizuki's reinterpretation was the “imponderable fluid” theory. Eighteenth century Newtonian science supposed that an imponderable fluid was involved in phenomena such as electricity, magnetism, light and heat. Imponderable fluid was believed to be so sparse that it would enter the spaces between the particles of a material object. Shizuki Tadao considered the imponderable fluid, as described in John Keil's work, to be *gi*. Shizuki translated John Keil's “imponderable fluid” into “*hōki* 方氣 (the released *gi*) ,”

mindful of its supposed ability to go into any kind of material objects and cause effects (Yoshida 1976:31).

As can be seen in the translated term “*hōki*,” Shizuki Tadao equated the imponderable fluid with *gi* released out of elements. In addition, this imponderable fluid, thought of as a fluid, would not lose or gain mass despite its movements in and out of other material objects. That nature was also seen as similar to *gi*. Shizuki Tadao posited that, as the universe was filled with phenomena involving electricity, magnetism, heat and light via imponderable fluid, *gi* was therefore omnipresent. According to this scheme, a vacuum without *gi* was impossible. Shizuki stated, “Anywhere where light reaches or *gi* comes across is not a vacuum.” (Shizuki 1802:160)

## 4.2 Unfathomable Force, Gravity

As mentioned above, Shizuki Tadao believed, through his interpretation of imponderable fluid, that the universe was filled with *gi* and *gi* was therefore the cause of all actions and phenomena. By dislodging the concept of a vacuum, Shizuki Tadao sought the origin and physical mechanism of gravitational action, and he found his answer in *gi*.

First, Shizuki Tadao concluded that all forces, including macro-forces like gravity 重力 as well as micro-forces like attraction 引力 between particles, are identical. Based on that inference, Shizuki Tadao concluded, “As the particles of a matter are *gi*, attraction between particles comes from *gi*.” (Shizuki 1802:149) “That (gravity) is actually a mutual pulling between the *gi* of all material objects and *gi* of the earth.” (Shizuki 1802:70) By interpreting the theories of matter in Newtonian science as *gi*, Shizuki Tadao ended up believing that all forces existent in the universe originate from *gi*.

However, Shizuki Tadao did not go beyond applying the theory of *gi* to the origin and mechanism of gravitational action. Although discontented with the silence of Newtonian mechanics on the subject, he nevertheless accepted the Newtonian perspective without attempting to come up with an alternative mechanical theory. While Choe Hangi, in this sense, was a philosopher who sought to establish his own independent philosophy, Shizuki Tadao was more of a student of Newtonian science and its worldview than an independent philosopher. Shizuki Tadao recognized that, following the Newtonian perspective, the origin and mechanism of gravitational action is something human intellect could not discover. He said that “Gravity originated from the unknown, but it acts on everything in the universe. (Shizuki 1802:69); The reason why gravity is

gravity is mysterious and cannot be measured.” (Shizuki 1802:162)

### 4.3 God's Will and Human Ethics

Principles of natural world and standard of human ethics cannot be separated in traditional Confucian philosophy. Choe Hangi's case, as already mentioned, exemplifies this perspective. He established the standard of human ethics using the existence and movements of *gi*. On the other hand, Shizuki Tadao as mentioned above, accepted the perspective of Newtonian science, and declared that the man cannot know the origin and mechanism of gravity. This means that Shizuki relinquished the traditional Confucian perspective of establishing the standard of human ethics based on the principles of the natural world. Shizuki Tadao had to find the humanity's moral standards through the supranatural God, the supposed founder of the universe.

According to Shizuki, man cannot know the ultimate principles behind nature, and therefore cannot deduce the standard of human ethics from the principles of nature. That is why the seemingly perfect order of nature and its functions were attributed to the works of the creator. As Shizuki Tadao, like Newtonian scientists, accepted that the ultimate principles behind the nature cannot be known to the human intellect, he had no choice but to accept the concept of an omnipotent God the creator.

From acknowledging the omniscient God to setting up the standard of human ethics, Shizuki seems to have followed the logical path of Newtonian scientists. Shizuki Tadao praised the great knowledge of God the creator. Such praise is identical to that of Newtonian scientists. He said the following: “What a miraculous world it is. It is the most superb sight. If such great harmony was not founded by the omniscient (God), how could this even be possible? “(Shizuki 1802:41) Shizuki Tadao, then, concluded that the standard of human ethics is provided by God, and what human has to do is to discover the divine will of the creator and act according to it.

For Shizuki Tadao, as described, the morality of mankind was granted by the supranatural God instead of the principles of nature. Choe Hangi, on the other hand, did not recognize the supranatural God. For Choe, humanity's ethics can only be deduced from the principles of *gi*. Choe Hangi and Shizuki Tadao suggested completely opposite answers to the question of the existence of a supranatural God.

## 5. Conclusion

As explained above, these two intellectuals of premodern East Asia displayed both similarities and differences in their responses to Newtonian science. First, Choe Hangi and Shizuki Tadao were similar because they interpreted Newtonian science using the traditional East Asian concept of *gi*. The theories of *gi* served as the common intellectual foundation for premodern East Asian intellectuals. Seeing the Newtonian science through the *gi* paradigm, it appeared irrational that Newtonian science did not explain the origin and mechanism of gravitational action. It was obvious to premodern East Asian intellectuals that *gi* constituted the origin and physical mechanism of gravitational action. That is the reason why both Choe Hangi and Shizuki Tadao problematized Newtonian science and sought to explain gravitational action using the *gi* concept.

Despite the common foundation, however, the natural philosophies of Choe Hangi and Shizuki Tadao differed significantly. Choe Hangi established his own natural philosophy based on the theory of *gi*, creating an independent mechanics of *gi* from the Newtonian one, and in the end, he discarded Newtonian mechanics. Not only did Choe Hangi not recognize the supernatural God, he explained all natural phenomena using the theory and mechanics of *gi*. Choe Hangi even deduced human ethics from the movements of *gi*. In short, *gi* was the only principle needed to explain the existence and significance of nature in Choe Hangi's natural philosophy.

On the other hand, Shizuki Tadao sought to discover the origin and mechanism of gravitational action by applying the concept of *gi*. However, Shizuki did not exert himself to invent an independent mechanics and philosophy of *gi* with amount of dedication Choe Hangi had. In the end, Shizuki Tadao accepted the perspective of Newtonian science admitting that the origin of gravity cannot be understood. At that point, Shizuki could no longer deduce human ethics from the principles of nature, and had to rely on the concept of a creator-God. By failing to establish an independent natural philosophy of his own, Shizuki Tadao, despite his usage of *gi* philosophy in interpreting Newtonian science, ended up accepting Newtonian science as well as its God.

It is equally important to note that the Newtonian science Choe Hangi and Shizuki Tadao understood was not the Newtonian science as it was in the West. Western science in premodern East Asia constituted context-dependent knowledge which East Asian intellectuals interpreted in their own cultural and historical context, and new thoughts grew out of that fusion of knowledge.