Scholarly Study of *Hong* (Rainbow) in the Ming and Qing Dynasties

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Abstract: This paper focuses on how Chinese intellectuals discussed and researched rainbows in late Ming and early Qing Dynasty. Many of them considered the rainbow as a phenomenon that occurred under certain conditions of sunshine and raindrops, which could be described with terms related to *qi* (气) of *yin*/*yang* (阴/阳). Some of them had the knowledge of duplicating rainbows by "spraying water opposite to the sun". There were also popular conceptions that rainbow was a sign of salaciousness and rainbow could siphon water, both of which had a long history in Chinese context. Scholars also discussed other phenomena similar to rainbow such as solar halo, lunar halo, parhelion and parselene. Those discussions were not held in wider society, yet they were the sign of how Chinese intellectuals rationalized their research into natural philosophy.
Keywords: rainbow, late Ming and early Qing, natural history, natural philosophy

According to Yan Chaoyin in *Qinghongfu* 晴虹赋 (Ode to Rainbows in the Sun), rainbows are described as, "Born in *qi*, lingering in air, it is looming, gracefully and dimly. Bright up and down, the entire be integrated in the mist." (Yan, 1983-: 349) Rainbows are imbued with a sense of beauty by poets. Nevertheless, in some contexts rainbows are deemed an omen of good or bad luck, and as a result, they are considered taboo. For instance, in the *Shijing* 诗经 (The Book of Songs) it is written, "Once a rainbow comes in East, nobody dares to violate the taboo to point at it." Anthropological studies of religion reveal that the rainbow is considered taboo among many different nations and cultures. When Christian missionaries introduced western natural science to China during the transitional period between the Ming and Qing dynasties, ideas about the rainbow influenced Chinese scholars. This essay will use various articles to analyze the discussion about the rainbow, including *Gezhicao* 格致草 (Rules of Astronomy) by Xiong Mingyu and *Tianjing huowen* 天经或问 (Inquiries of Celestial Phenomena) by You Yi, etc. The aim of the essay is to gain a better understanding of scholarly discussion of the

rainbow in the Ming and Qing dynasties, while looking into the sources of these perceptions.

I. WHAT IS THE RAINBOW?

According to modern science, the rainbow is a natural phenomenon that is caused by the refraction and reflection of sunlight through droplets in the air. Yet, intellectuals during the Ming and Qing dynasties had no idea of any concepts of geometrical optics like refraction and reflection. Consequently, the way Chinese scholars perceived the rainbow was based mainly on vague terms, being drawn from traditional Chinese concepts and merging western natural philosophy that originated from Jesuits.

Influenced by western knowledge, scholars such as Xiong Mingyu and Fang Yizhi, considered the rainbow as a natural phenomenon that occurred under certain conditions of sunshine and raindrops. Xiong Mingyu oberserved in *Gezhicao,* "The sun is on one end, opposed to the rain. However, man observe *qi* in between, the shadow of sunshine through rain came into eyes. Consequently, the rainbow switches from west at dawn to east at dusk." (Xiong, 2014: 219-220) From the point of formation, the description of rainbows matches the scientific explanation and accounts for the location of the rainbow being in the west at dawn but in the east at dusk. The primary reason for this is that people are usually able to see a rainbow only when they have their back to the sun. As such, when the sun is in the east, only those facing west can see the rainbow, and vice versa. The rainbow and the sun are always in the opposite position.

There also exists texts about the formation of the rainbow in *Tianjing huowen,* and *Gujin shiyi* 古今释疑 (Explanations for the Miracles of Then and Now) by Fang Zhonglü. As described in *Tianjing huowen*, the rainbow is formed through the mapping process of sunshine on clouds, that is, a cloud layer diagonally opposite the sun blocks the light. Thus, the *qi* of the sun drops while the heat gravitated by the *qi* of the sun spins upwards from the ground. The heat and *qi* of the sun meet each other in cumulus clouds, and the rainbow appears when sunshine passes into the cloud (You, 1983-: 632). You Yi's discussion is comparatively vague. For example, some expressions like "日气下垂" (roughly paraphrased as "qi of the sun is dropping"), have no counterpart in modern concepts. It is believed that rainbows are generated by *qi* of water when exposed to the sun at a point

where the relative position of the rainbow and the sun is opposite. In other words, where the sun is in the east, the rainbow must be in the west; and where the sun is above, the rainbow will be below, as described in *Gujin shiyi*. Fang Zhonglü also mentioned that the rainbow is an annular shape. The reason people see a semi-circle one was that the other part is hidden underground (Fang, 1995: 654), which is in line with scientific fact. Actually, seen from the sky, the rainbow is a round circle. However, it is difficult for people to have a full view of it when standing on the ground.

Another intriguing suggestion is that the rainbow can be man-made. As depicted in *Gezhicao,* if the sun is in the east, water is sprayed towards the west side of a person, and as a result droplet are red and green when observed from between (Xiong, 2014: 220). The record of man-made rainbows is quite interesting because such a simple experiment can easily be replicated. The fact that odd phenomenon in nature can be reproduced suggested the possibility of scientific research method. Xu Guangtai argued that *Gezhicao* must have been influenced by the Jesuit, Alfonso Vagnoni (1566–1640), in *Kongji gezhi* 空际格致 (The Principles of Four Elements in Space), because there were several depictions of "spraying water opposite to the sun" (Vagnoni, 1995: 714). The experiment of "spraying water" can also be found in ancient literature. Fang Yizhi mentioned, in *Wuli xiaozhi* 物理小识 (Notes on the Principle of Things), that there were some descriptions about the man-made rainbow experiment as early as in *Piya* (埤雅), by Lu Dian of the Song dynasty. "Lu Dian sprayed water towards the sun for a rainbow." (Fang, 1983-: 782) According to *Piya*, if one sprays water facing the sun, a rainbow may appear (Lu, 2008: 203). *Qixiu leigao* 七修类稿 (A Literary Sketch of Historical Absences in Seven Items) by Lang Ying, cited from *Piya*, "Thus, previous sages thought of the cloud too thin to block sunshine and the rainbow came into being from the mapping process of the sun on clouds. Now, water is sprayed to the sun and seen aside, the rainbow is created." (Lang, 2001: 29) The initial part of this paragraph relates to the fact that the ancients found a rainbow can be seen when the sun light passes through raindrops, the source of which is Kong Yingda's notes and commentaries in *Liji: Yueling* (礼记 • 月令 The Book of Rites: Rules of the Moon) (Dai, 1999: 482). Yet, the end section provides accurate details about how a rainbow can be observed by spraying water opposite to the sun. Also worth mentioning, is that an even earlier record of man-made

rainbows is found in *Xuanzhenzi* (玄真子), by Zhang Zhihe in the Tang dynasty. It is recorded that, "The phenomenon of rainbows can be seen when water is sprayed opposite to the sun." (Zhang, 1985: 44)

Under most circumstances, scholars in the Ming and Qing dynasties preferred to describe the rainbow with terms related to the *qi* of *yin*/*yang* (阴/阳). As cited from the previous definitions in *Qixiu leigao,* by Lang Ying, the rainbow is the integrated the *qi* of *yin*/*yang* (Lang, 2001: 29). In Xie Zhaozhe's, *Wuzazu* 五杂组 (Essays of Five Sections), the rainbow is also considered the *qi* of *yin*/*yang* with a tangible exterior and an intangible interior, the existing span of which is very short (Xie, 2001: 12). Although there was one perception that rainbows are generated by sunshine through raindrops in *Gezhicao*, Xiong Mingyu still agreed with the idea that the formation of rainbows is caused by "the movement of *yang qi*" in Sima Qian's, *Records of the Historian* (史记) (Xiong, 2014: 221). As a result, based on the *qi* of *yin*/*yang* and physical observations, the two different explanations for the formation of rainbows coexisted in the same book. From the view of modern scientific knowledge, the discussion on the mechanism underlying the formation of rainbows was too ambiguous to be taken seriously, and far from a result of scientific research.

II. RAINBOWS: SALACIOUS *QI* AND SIPHONING ABILITY?

Generally speaking, scholars of the Ming and Qing dynasties held two views on the characteristics of rainbows: the first was that they were the sign of salaciousness, that is, the salacious *qi* existing in the universe; the second was that rainbows could drink water and alcohol like animals. The former could be a superstitious concept left behind by ancestors due to a lack of an accurate explanation for the rainbow, while the latter originated from exaggerated gossip and hearsay. Other differences between the two theories can still be observed if a thorough investigation is made on the details and their sources.

The conception of considering the rainbow as a sign of salaciousness developed in a system that does not actively look for an explanation for natural phenomenon. Probably dating back to the Eastern Han dynasty, Zheng Xuan provided an explanation for a sentence from the *Book of Songs: Didong* (诗经 • 蝃蝀), which can be rendered as "once a rainbow comes in the east, nobody dares to violate the taboo to point at it." As Zheng

Xuan notes, "The rainbow is a taboo for people so that nobody dares to point at it, the situation of which is quite similar to that of a woman of easy virtue eloping with fancy man no one is emboldened to look at." (Mao 1999: 204) Zheng Xuan compared the rainbow to a lady eloping with a man, as a result of which the idea of "rainbows symbolizing salaciousness" became one of the moral creeds of Confucianism for criticizing female elopement. The *Shijizhuan* (诗集传) by the Song dynasty scholar Zhu Xi added, "The rainbow is formed when bright sunshine comes out of clouds after rain. Its essence implies sexual intercourse because the sun represents *yang* while the rain stands for *yin*. *Yang* from the sun and *yin* from the rain should not have integrated with each other but turned out to be mixed, so the rainbow is defined as salaciousness." (Zhu, 2011: 42) What Zhu Xi intended to do was to provide further proof that the rainbow was the outcome of an improper intercourse between *yin* and *yang*. Though the notes Zheng Xuan and Zhu Xi made on the rainbow were not scientifically accurate, they succeeded in promoting the popularity of the "rainbows representing salaciousness", due to their influence in academia.

This perception still prevailed even during the Ming and Qing dynasties. Furthermore, *Wuli xiaozhi,* which simply approaches natural phenomena by researching objects, could not escape the impact. It is mentioned in *Wuli xiaozhi* that a wizard or alchemist made medical philter from *Hongchong* (a kind of red worm) discovered in the East China Sea. The legend about making philter from Hongchong acts as the counterpart to the conception of the rainbow as a symbol of salaciousness (Fang, 1983: 782-783). However, Fang Yizhi did not impose any doubt on this idea.

Nevertheless, some intellectuals were skeptical towards the notion of "rainbows representing salaciousness". *Gezhicao* by Xiong Mingyu disputed the notes made by Zhu Xi and other scholars. Xiong Mingyu argued, the definition about the rainbow being the symbol of salacious *qi* in *Shi-ji Zhuan* by Zhu Xi is false (Xiong, 2014: 242). In addition, Wang Fuzhi criticized Zhu Xi in *Zhangzi zhengmeng zhu* 张子正蒙注 (Notes and Commentaries of Zhengmeng), as Wang believed that rainbows were only natural phenomena, without a tangible material carrier caused by the penetration of sunshine through drizzle instead of salacious *qi* (Wang, 1988: 327). Among all the critics, the most powerful strike was from Lang Ying. He pointed out in *Qixiu leigao,* that the definition of "rainbows representing salaciousness" originated from *Huainanzi* (淮南子), with the

quotation, "I think Zhu Xi's conception about the rainbow is derived from the fairy tale in *Huainanzi*. Zhu directly cited the story without any double verification (Liu, 1989: 528). Although it was true as what it was depicted about rainbows in *Huainanzi*, no rainbow can be generated without the sun and drizzle. Therefore, what is required to form rainbows is the mapping of the sunshine through raindrops. Now, rainbows, if seen from the side, can be generated by spraying water in the sun. If this kind of artificial rainbow is also considered as salaciousness, it is quite probably a false recognition." (Lang, 2001: 58)

Anecdotes about the ability of rainbows to take food were widely spread through folklore. For example, Xie Zhaozhe remarked in *Wuzazu,* that during the Western Han dynasty, a rainbow descended to the ground to drink water from a well, and finally the well turned out to be waterless; a partial rainbow intruded the imperial palace for water and a gentleman appeared with the transformation of the gradually weakening rainbow. Additionally, in the Tang dynasty, a rainbow came for food and drink at a banquet. Speaking of those tales, Xie Zhaozhe did not hold an explicit attitude. On the one hand, he said that rainbows were *qi* of *yin/yang* without a material carrier, meaning it would be strange to hear of "the capability of rainbows to take food and water". On the other, he never refused to acknowledge the rationality of these seemingly absurd stories (Xie, 2001: 12).

Erya (尔雅) and *Shuowen jiezi* (说文解字) may be the origin of "the rainbow's ability to take food and drink". The reason for this conclusion is because the glosses and explanations for "*Hong*" (虹 the rainbow) and its character formation, as well as the etymology in the two masterpieces, are all written as "*Hong*", which is a kind of insect. The scholars of later generations often cited this definition of "*Hong*" when talking about the rainbow.

Shen Kuo, a scholar of great influence in the Song dynasty, used an anecdote about "the rainbow's power to siphon", which heavily influenced the spread of this belief about rainbows. As put in *Mengxi bitan* 梦溪笔谈 (Dream Pool Essays), during years of the throne of Emperor Shenzong in the Northern Song dynasty (A.D. 1069-1085), Shen Kuo was assigned as an envoy to Khitan. Just at the end of rain, he and his colleagues saw a rainbow in front of their camp. Both ends of the rainbow reached down into the creek, creating a picture of which seemed like siphoning water. Thus, orders were given to check the situation at the two

sides of the creek, only to find that the rainbow could only be seen when the observer was standing in the west facing east, and not vice versa. After a while, the rainbow started moving eastwards and vanished over the mountain (Shen, 2015: 203). What Shen Kuo stated in the book was very detailed, as outlined previously. Owing to the rules of how rainbows are formed, people can see it only when located between the sun and the rainbow. Furthermore, the rainbow will also move with the sun. Shen Kuo's record of his experience actually introduced a mistaken recognition. That is to say, the rainbow possessed a biological characteristic that enabled it to drink water from creeks or travel across mountains. Shen Kuo's story, as told through the quotation by Lu Dian (2008: 204), may also have had an effect on Zhu Xi. Zhu Xi admitted that he believed not only that the rainbow was the phenomenon of light and shadow after sun light travelled through drizzle, but also saw it as a tangible entity that could consume food and water (Zhu, 1986: 24).

Most academics in Ming and Qing dynasties held suspicious attitudes towards the hypothesis that rainbows could siphon water. Lang Ying considered it misinformation that previous ancestors relayed from one to another about this hypothesis, that is, a creature was mistaken as the rainbow due to it looking like the rainbow (Lang, 2001: 29). Xiong Mingyu also denounced this hypothesis in *Gezhicao,* by arguing that the rainbow could not feed or drink for lack of a mouth and belly. Instead, he offered an alternative explanation that the phenomenon was essentially generated as vapor ascended, which looked like rainbow siphoning water (Xiong, 2014: 242).

A rhetorical question in *Inquiries of Celestial Phenomena* by You Yi revealed the logic in the statement of "rainbows siphoning water". You Yi asked, "蝃蝀是否是虫？若是虫，如此大的虫，如何能在瞬间出现或消失？若虹只是云霞一类的自然现象，为何又能吸水饮酒?" ("Are rainbows really a kind of worm? If so, how could such a huge worm appear or disappear all of a sudden? Supposing that it is only a natural phenomenon, why can it suck water or drink?"). He believed that the rainbow was just a phenomenon caused by sunshine shedding over clouds rather than a living being, like a worm. The rumor about rainbows siphoning water can be explained as sun light evaporates heat from the ground, as opposed to the rainbow drinking and eating. That is why water and wine can ascend along the parabolic curve of the rainbow (You, 1983-: 632). In *Wuli xiaozhi,* by Fang Yizhi, there is an individual chapter about

rainbows, but there is no discussion about whether the rainbow can drink water or not, because he rejected such hypotheses. Wang Fuzhi agreed with Fang's idea by saying, "Those who state rainbows can drink water from the well are those who have never been enlightened." (Wang, 1988: 12: 327)

III. PHENOMENA OR COLORS SIMILAR TO RAINBOWS

The rainbow, solar halo, lunar halo and "double images of both the moon and the sun" are all atmospheric optical phenomena. The difference between them is that the rainbow can usually be seen only when the observer turns their back to the sun, while it is required to face the sun or the moon to see solar and lunar halos. According to modern optical knowledge, the rainbow is generated after sunlight has experienced refraction, reflection and another refraction through raindrops in the air, while halos are formed through light refracting through ice crystals in cloud layers.

During the Ming and Qing dynasties, scholars paid attention to this kind of phenomenon and tried to make sense of it, but their suggestions are too ambiguous for modern thought. As stated in *Gezhicao*, it is believed that solar and lunar halos and comet flares are formed because *qi* arose to the sky. All of them are *qi* of the ground attracted by the sun and the moon in essence, but *qi* of halos are below rather than above the sun and the moon. Xiong Mingyu listed some examples to argue that the formation mechanism of halos was similar to how visually impaired people see annular shadows when staring at lamplights (Xiong, 2014: 201, 267). In *Wuli xiaozhi*, it is also recorded that Fang Kongzhao, the father of Fang Yizhi, discussed with friends the argument of "halos similar to rainbows". Fang Kongzhao thought that halos should be annular, and semi-circle halos like rainbows are due to being half unseen (Fang, 1983-: 782).

The description of double images of both the sun and the moon is actually parhelion and paraselene. Similar to halos, parhelion and paraselene are double images of the sun and the moon caused by refraction and reflection of light through ice crystals in cloud layers. In *Gezhicao*, Xiong Mingyu argued that double images of the sun and the moon did not prove the birth of another sun or moon. If there was really another sun or moon, it would be visible and recorded in every country,

which was not consistent with the truth. He believed that this kind of phenomenon was similar to water reflection and was generated by "oddly formed *qi*" (Xiong, 2014: 230-231). Also, You Yi made a comparatively rational judgement on the same thing in *Inquiries of Celestial Phenomena*. He held the opinion that if the sun was facing a bulk of thin cloud, sunbeams would penetrate it, but where there was black thick cloud, sunshine could not travel through it and had to be thrown back on the thin cloud. As a consequence, dual-images of the sun occurred. Under such circumstances, a third image would be produced if another cloud came along (You, 1983-, 632-633). Though Xiong Mingyu and You Yi used observation to interpret the double-image situation, the terms they used were not explicit enough to be considered scientifically accurate.

Due to the colorful visual effect of optical phenomena in atmosphere, including the rainbow, scholars of the Ming and Qing dynasties also took the formation of colors into consideration when discussing rainbow phenomenon. You Yi cited "the integration of water and fire" as the explanation for green and red colors of rainbows in *Inquiries of Celestial Phenomena*. In his opinion, rainbows should have been colorless and the green is from the *qi* of water while the red is caused by the *qi* of fire. With the fusion of water and fire, the color of the rainbow varies through the combination of red and green (You, 1983-: 632). Fang Zhonglü offered a similar explanation for its color in *Gujin shiyi* (Fang, 1995: 654-655). According to *Inquiries of Celestial Phenomena,* in the discussion of tiers of colors about rainbows, the form of rainbows is an arc with a yellow layer exterior, green middle and red interior (You, 1983-: 632). Based on modern knowledge, this kind of statement is incorrect because the visual effect of rainbows is usually red, yellow and green or purple from outside to inside, which is opposite to what You Yi recorded.

Xiong Mingyu wrote in *Gezhicao* that the color of sky is beyond the Five Elements. The sky-blue is not the true color of the sky and the color people see is only visual illusion (Xiong, 2014: 191-192). This kind of conception probably results from Jesuit influence. Alfonso Vagnoni distinguished two ways of forming colors in the *Principles of Four Elements in Space*, namely, realistic color and illusionary color. Realistic color is born from the fusion of cold, heat, dry and damp, which could not be seen in objects made of pure elements, but resulting from a "hodgepodge" mixture. Illusionary colors are generated by the beam reflected from objects, which is easy to come and go (Vagnoni, 1995: 713). Fang Yizhi

drew the conclusion in *Wuli xiaozhi* that convex lenses, like convex gemstones, will make a beam converge into one strip, and a prism, like prism-shaped gemstones, make it disperse into five colors. For example, the luminous stone of Mt Emei is a hexagonal prism with six facets, and a crystal paperweight that is a triple prism with three facets, can disperse a sunbeam into five colors. When sunshine goes through a waterfall or water is sprayed between walls, five colors will be visible. In nature, the five-color phenomena, share the same principle of the prism splitting the beam into five colors (Fang, 1983-: 911).

Therefore, the statement in *Wuli xiaozhi* is considered by researchers of scientific history to be important historical material about optics. To some degree, Fang's understanding of the formation of five-color phenomena aligns with the spectrum principle of sunlight. It is a pity that he did not investigate the spectral phenomenon of prisms based on his findings, or further explore the principle behind it. From our point of view, there is a huge gap between understanding how light splits and making valuable scientific findings. Supposing mathematical methods were adopted to describe the refraction of a beam (that is, to measure incident and reflex angles), imagination is still required to conclude that natural sunlight is composed of various colors of light, the principle of which Isaac Newton's dispersion experiment with prisms is based on.

CONCLUSION

This article has conducted a thorough investigation into texts about rainbows written by scholars of the Ming-Qing dynasties. However, this discussion did not enter into wider society. According to statistics, the narrative attribution of disasters to rainbows is seldom seen in works of natural philosophy. Only in *Gujin shiyi*, Fang Zhonglü threw doubt over this kind of conception (Fang, 1995: 655). How do popular books that reflect common wisdom describe rainbows?

In *Tianzhongji* 天中记 (A Reference Book of Tianzhong), Chen Yaowen cited the record from *Jinshu* 晋书 (The Book of Jin Dynasty). Rainbows pervaded all over the sky in the fifth year of *Jianxing* (建兴) during the Jin dynasty, which was the same year that Liu Cong assassinated Emperor Min (Chen, 1983-: 965: 146). Geomancy about rainbows can also be applied to military combat. Chen Yuanlong wrote in *Gezhi jingyuan* 格

致镜原 (Probe into Essences of Everything for Knowledge), that when sieging a city, if there was a rainbow siphoning water from the south, then troops should follow the direction of the rainbow to achieve victory (Chen, 1983-: 1031: 53). Owing to the fact that authors of natural history books usually do not distinguish the content, this kind of work can be considered an "encyclopedia" of folklore on the rainbow. In the late Ming dynasty, the popular reference books aimed at the masses were mostly published by booksellers for profit. These kinds of books usually recorded catastrophes and ghost stories about phenomenon such as rainbows, halos, and parhelion, which were presented as a fortunetelling picture with comments.

Like the reference book of natural history, the statements about rainbows in popular encyclopedias books is also chaotic. The texts are not logically rigorous enough to record reliable stories. For instance, in *Xinke Tianxia Simin Bianlan Santai Wanyong Zhengzong* (新刻天下四民便览三台万用正宗), there are paradoxes in the divination of the solar halo. To be specific, the solar halo not only forecasts the drought, but also prophesizes heavy rain (Yu, 2011: 215, 216). Authors of daily reference books select absurd and weird stories that are popular due to their sensationalism, which appeals to wider audiences. Compared with the scholarly reference book of natural science, household books for civilians recording anecdotes about rainbows were broadcast more widely.

Another significant source of natural knowledge is official histories. Among them, meteorological phenomena like wind, rain, snow, and hail, are recorded in both *Wuxingzhi* 五行志 (Records of Five Elements) and *Tianwenzhi* 天文志 (Records of Astronomy). No text about rainbows is included in *Records of Five Elements,* however records on halos and fogbows are printed in *Records of Astronomy*. Accurate dates when solar halos and fogbows occurred were recorded in *History of the Yuan dynasty: Records of Astronomy*, in which fogbows, solar halos and eclipses are all categorized in the same section (Song, 1976: 1002-1004). In *History of the Ming Dynasty: Records of Astronomy*, a section called "anomaly celestial phenomena by halos" documented the precise year and outlined a description of solar halos, fogbows and solar prominence (Zhang, 1974: 413-416). But authors of official histories did not extend any theories on the implication of these phenomena.

In conclusion, the scholarly work of the Ming and Qing dynasties did

not address or comment on rainbows thoroughly enough to be considered accurate. They usually mixed rational speculation with ridiculous concepts in the same discourse, resulting in skepticism towards their anecdotes and legends.

Notes

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