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The Historical Formation and Academic Characteristics of the Tao-Ge School in Daoism

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Abstract: The Tao-Ge School refers to the Taoists Ge Hong and Tao Hongjing as the main representatives in the Six dynasties period. It also includes numerous alchemists, physicians, and craftsmen who constituted a Daoist science and technology school in the Middle Ages. This school comprised an academic community characterized by scattered, small master–apprentice or family inheritance groups. It was founded and became popular between the 4th and 12th centuries. With alchemy, medicine, and technology as its main practice, it reflected the scientific and technological academic characteristics of cognitive positivism and rationalization, which emphasized an active understanding of nature, commitment to technological innovation, and a theoretical construction of knowledge. Historically, the Tao-Ge School had a profound impact on the practical methods and theoretical perspective of ancient Chinese science and technology, standing as an example of a school of science and technology with traditional Chinese cultural characteristics.

Keywords: Tao-Ge School; the Middle Ages; Daoism; school of science and technology

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1. Introduction

It is difficult to imagine that the brilliant scientific and technological achievements of ancient China were merely caused by scattered individual experiences or practical craftsmanship, without the support of a rational thought paradigm and academic tradition. Setting aside its fortuitous history, behind the rich scientific and technological achievements that emerged are thought and cognitive traditions accumulated by countless thinkers and practitioners. In fact, just as the Milesian and Pythagoras Schools advocated rational cognition around nature in ancient Greece, the Tao-Ge School, based on Chinese culture, inclined toward understanding nature and technological inventions by emphasizing rational cognitive thought.

However, in the history of ancient Chinese religious culture, the Tao-Ge School, which was popular between the 4th and 12th centuries, has rarely been discussed by scholars (Cai 2007). This is likely because it is not like mainline Confucianism, the tradition of Lao Zi and Zhuang Zi in Daoism, or Zen Buddhism, which are humanistic and spiritual disciplines devoted to ethical systems and moral character. In contrast, the Tao-Ge School involved the study of *shu shu* 數術 (including astrology, numerology, divination, and talismans) and *fang ji* 方技 (medical technology and knowledge), focusing on nature, medicine, and smelting. It has made far-reaching contributions to the practice and theoretical development of ancient Chinese science and technology from a unique perspective. This article discusses the Tao-Ge School's connotations and value for Daoist science and technology history.

2. Historical Formation of the Tao-Ge School

The Tao-Ge School was mentioned in the manuscript *Daode zhenjing cangshi zuan weikai tike wensu* 道德真經藏室纂微開題科文疏, written by Xue Zhixuan 薛致玄 during the Northern Song dynasty. Volume 5 of the work states:

> In 1088, the famous Taoist Chen Jingyuan 陳景元 went to Dongjing (the capital of the Northern Song Dynasty) to work and meet Su Song 蘇頌. Su Song said to Chen Jingyuan, "You should recruit more disciples and teach them your academic knowledge. Otherwise, the Tao-Ge School may be lost" 元佑三年, 陳景元因過京師 . . . . . 朝廷複還右街道職. 右僕射蘇頌謂曰: 真靖當以所業授門弟子, 不爾, 則恐陶葛之學不傳於來世. (Xue 1988, p. 371)

Su Song 蘇頌 was one of the greatest scientists in ancient China (Yan 1986, p. 158). The Tao-Ge School originated as a result of Su Song's advice given above. Su Song highly valued the Tao-Ge School—which included astronomy, geography, medicine, alchemy, and other intellectual traditions—and learned a great deal from it. In fact, Su Song's scientific and technological thought and knowledge is deeply rooted in Daoism (Cai 2011, pp. 30–34). During this time, the Taoist academic tradition was undergoing major changes, which have been called the "Taoist School sudden change" 道家之學翕然一變 (Xue 1988, p. 731); the Lao-Zhuang School and the inner elixir (*nei dan* 内丹) began to flourish, while the Tao-Ge School and the outer elixir (*wai dan* 外丹) were gradually declining. The dialogue between Su Song 蘇頌 and Chen Jingyuan 陳景元 thus revealed a major transition in the history of ancient science and technology. How did the Tao-Ge School come into existence and spread?

Historical material confirms that the Tao-Ge School was created by Ge Hong 葛洪 of the Eastern Jin dynasty and Tao Hongjing 陶弘景of Southern Liang. Ge Hong was not only the most famous alchemist in Chinese history but also one of the most outstanding medical scientists. He believed that "golden elixirs" were the most important medicine to enable Daoist cultivators to obtain longevity and immortality—"I have collected and read a lot of books on regimen" 餘考覽養性之書, 鳩集久視之方, and "These Books show that elixir is the decisive factor for longevity" 莫不以還丹金液為大要者焉 (Ge 1988a, p. 181). Similarly, "medicine" is the key factor to maintaining good health—"health preservation is based on not harming the body" 養生以不傷為本 (Ge 1988a, p. 221); "while cultivating Daoism, we should also learn medical skills" 是故古之初為道者, 莫不兼修醫術, 以救近禍焉 (Ge 1988a, p. 229). To this end, Ge Hong wrote far-reaching medical masterpieces, including *Yuhanfang* 玉函方 and *Zhouhoubeijifang* 肘後備急方. Tao Hongjing agreed with and followed Ge Hong's perspective on attaching importance to alchemy and medicine and offered that cultivating Daoism and becoming an immortal "must take medicine first" 莫不以藥道為先 (Tang 1986, p. 16), and he (like Ge Hong) wrote numerous innovative and important medical books, such as *Bencaojingjizhu* 本草經集注, *Buquezhouhoubaiyifang* 補闕肘後百一方, and *Yao zong jue* 藥總訣. Their shared emphasis was on the importance of alchemy (*Wai dan* 外丹) to facilitate longevity and medical assistance in the practice of Daoism; further, they advocated for technological innovation and a curious spirit aimed at acquiring knowledge. At the same time, they attached great importance to positivization and rationalization of knowledge. Joseph Needham conducted a systematic and in-depth study of the Taoist scientific and technological thought and achievements in the Ge and Tao age and spoke highly of them (Needham 1976, pp. 75–117). He pointed out, "Ko Hong (葛洪) was the greatest alchemist of his age, and the greatest Chinese alchemical writer of any age"; "the most celebrated in 5th- and 6th-century China was undoubtedly Thao Hung-Ching (陶弘景), who was also a great physician pharmaceutical naturalist like Ko Hong" (Needham 1976, pp. 79, 119).

During the Jin and Liang dynasties (4th–6th centuries), Ge and Tao became famous as Taoist science and technology masters, with alchemy and medicine as their main associated fields. They were widely respected and became known as "Ge-Tao" or "Tao-Ge". At that time, Yu Yuanwei's 庾元威 *Lun shu* 論書had already mentioned "Tao and Ge" (Zhang 1986, p. 127). During the Tang and Song dynasties, Ge and Tao gained even more reputation in this period. Literati often praised Ge and Tao in their poems and regarded them as outstanding alchemists and medical experts. For example, "Tao and Ge's prescription for immortality is a secret and has not been taught to others, so it has remained unknown for thousands of years" 陶葛金丹訣, 千年秘不傳 (Lu 1986, p. 670); "From Qi-Suo to Tao-Ge,

many immortals are good doctors" 請看岐叟至陶葛, 神仙多是良醫成 (Xie n.d., p. 29). At the same time, they were also regarded as the most learned Taoists: "Ge and Tao, the world knows them as Taoists, who are individuals with all-round natural knowledge and technology" 葛陶二君, 世共知為有道之士, 於學無所不貫, 於術無所不通 (Ge 1988b, p. 1). Thus, the Tao-Ge School was a traditional school generally recognized by the Jin, Liang, and Song dynasties. Its philosophical and academic characteristics were erudition proficiency in divination and advocacy of science and technology (see Table 1).

Table 1. The philosophical and academic characteristics of the representative figures in the Tao-Ge School.

Representative Figure	Time Period	The Philosophy and Academic Characteristics
Ge Hong 葛洪	283–363	He offered the thought: "understand the essence and law of movement of the world" 欲盡物理 and believed that "the various alchemy and medicine technologies can promote immortality". 藉衆術之共成長生 (Ge 1988a, p. 216)
Tao Hongjing 陶弘景	456–536	He offered the concept that "you don't understand the things, and you deeply think it's a shame" 一事不知, 深以為恥; specifically, we should understand concepts, such as "Yin-Yang and the five elements (metal, wood, water, fire, and earth), practicing divination, geomantic omens, and medical skills" 尤明陰陽五行, 風角星算, 山川地理, 方圖産物, 醫術本草 (Li 1975, p. 1898).
Su Song 蘇頌	1020–1101	He stated that "grasp the knowledge of divination, astronomy, shanjing (includes mythology, religions, etc.) and medicine, can understand everything in nature" 圖緯, 星官, 山經, 本草, 無所不通 (Su 1986, p. 127).

It should be noted that this "science and technology school" does not refer to a strictly fixed school of inheritance, for example, a formal association, but was composed of many small-scale Taoist groups, mainly working in Taoist alchemy, medicine, and theurgy. These groups often had teachers, pupils, or families constituting their lineage and practiced secretly. The succession of teachings from Ge Hong to his disciples and their group composition are extremely complex. Joseph Needham's research pointed out that there are two lines of Ge Hong's teaching: One is to learn from Zheng Yin 鄭隱, which can be traced back to Ge Xuan 葛玄, Zuo Ci 左慈, Li Zhongfu 李仲甫, or Wang Sizhen 王思真, Yin Changsheng 陰長生, ... Ma Mingsheng 馬鳴生, An Qisheng 安期生, and Heshang Zhangren 河上丈人. The other is from Bao Liang 鮑靚, which can be traced back to Lu Zihua 呂子華, Yin Changsheng 陰長生, ... Ma Mingsheng 馬鳴生, An Qisheng 安期生, and Heshang Zhangren 河上丈人. It can be seen that this path is interrelated, and there are branch groups such as Wei Boyang 魏伯陽, Xu Zongshi 徐從事, Chunyu Shutong 淳于叔通, Hu Gangzi 狐剛子, Xu Mai 許邁, Yang Xi 楊曦, Ding Yi 丁義, and Wu Meng 吳猛. (Needham 1976, pp. 76–78) It is worth noting that Ge Hong also taught the Dao of alchemy (*dan dao*丹道) and medical prescriptions to his disciples, such as Huang Yeren 黃野人 (Zhao 1988, p. 237) and Tengsheng 滕升 (Ma 1986, p. 653). They learned many kinds of *danjing daoshu* 丹經道術 (including Taoist magic arts and alchemy), the medicine technology of immortality and alchemy, which had a great influence. Although Tao Hongjing 陶弘景 was not a disciple of Ge Hong's lineage, he inherited Ge Hong's alchemy, medical thought, and knowledge, and can be viewed as a successor to Ge Hong's thought. According to historical data, Tao Hongjing's family was a medical family, and his grandfather "(Tao Long 陶隆) was good at using medicine" 陶隆善解性 (Zhang 1988, p. 730). Under the family's influence, Tao Hongjing learned *dan dao*丹道 and medicine skills from Sun Youyue 孫游嶽 who is a famous Taoist, and Tao "traveled through famous mountains, looking for immortal medicine" 遍歷名山, 尋訪仙藥 (Li 1975, p. 1897). In Mount Maoshan 茅山, Tao

Hongjing and his disciples (Zhou Ziliang 周子良, Huan Kai 桓闓, and Sun Wentao 孫文韜) formed an academic Taoist group that advocated for knowledge and craftsmanship—the Maoshan sect of the Shangqing School 上清派茅山宗. Thus, the ideas foundation of the Tao-Ge School was established. From the 6th to the 8th century, the Maoshan sect was successively led by Taoist Wang Yuanzhi 王遠知, Pan Shizheng 潘師正, Sima Chengzhen 司馬承禎, and Li Hanguang 李含光 (Needham 1976, p. 121).

Since Ge and Tao, this form of Taoist group inheritance, which is a mixture of master–apprentice and family relations, has continued and developed in secret. For example, in the Tang dynasty, Sun Simiao 孫思邈 and his disciples Meng Shen 孟詵, Zhang Ding 張鼎, and Lu Zhaolin 盧照鄰 formed a medicine group (Ouyang 1975, p. 5597); Huang Gong黃公 and Cao Yuan曹元 formed a medicine group originated from Hua Tuo華佗 (Wang 1986, p. 106); Zhang Wenzhong 張文仲, Li Qianzong 李虔縱, and Wei Cizang 韋慈藏 composed a famous doctors' group (Liu 1975, p. 5099); Chen Zangqi 陳藏器 and Ri Huazi 日華子 followed Tao Hongjing's herbal medicine knowledge (Xu 1986, p. 661); a famous doctor, Wang Bing (Qi Xuanzi) 王冰 (啓玄子, learned from Meng Shen 孟詵and Xuanzhu 玄珠先生; and Hu Yin 胡愔, a famous female Taoist doctor, originated from the lineage of Wei Huacun 魏華存, the founder of a sect of the Shangqing School (Gai 1999, pp. 22–24). In the Song dynasty, the official medical research group was composed of Taoist Ma Zhi 馬志and Hanlin medical officials Zhai Xu 翟煦, Zhang Su 張素, Wu Fugui 吳複圭, Wang Guang 王光, Chen Zhaoyu 陳昭遇, and An Ziliang 安自良 (Tang 1986, p. 24); the medical research group established by Taoist Wang Huaiyin 王懷隱, Wang You 王佑, Zheng Qi 鄭奇, and Chen Zhaoyu 陳昭遇 (Tang 1986, p. 24), and Su Song 蘇頌 and Su Yi's 蘇繹 family, who followed Ge, Tao, Sun's *dan dao*丹道and medical knowledge (Cai 2011, pp. 30–34). Furthermore, there were numerous Taoist groups who practiced the outer elixir (*wai dan*, 外丹) and medicine in this period, such as the waidan jinsha School 外丹金砂派 and liugong School 硫汞派. Representatives of this group include Zhang Jiugai 張九垓 (author of *zhangzhenren jinshi lingsha lun* 張真人金石靈砂論), Chu Ze 楚澤先生 (author of *Taiqing shibi ji* 太清石壁記), Shen Zhiyan 沈知言 (author of *Tongxuan mishu* 通玄秘術, derived from Taoist Ma Ziran 馬自然, Zheng Gong's 鄭公 writings), Zheng Siyuan 鄭思遠 (author of *Zhenyuan miaodao yaolve* 真元妙道要略), Dugu Tao 獨孤滔 (author of *Danfang Jianyuan*丹房鑒源), Zhang Guo 張果 (author of *Yudong dashen dansha zhenyaojue* 玉洞大神丹砂真要訣), Jinlingzi 金陵子 (author of *Longhu huandan jue* 龍虎還丹訣), Chen Shaowei 陳少微 (author of *Dadong lian zhenbaojing jiu huan jindan miaojue* 大洞煉真寶經就還金丹妙訣), Jin Zhupo 金竹坡 (author of *Dadan qiangong lun* 大丹鉛汞論), Mei Biao 梅彪 (author of *Shi yao er ya* 石藥爾雅), Peng Xiao 彭曉 (author of *Cantongqi fen zhang tong zhen yi* 參同契分章通真義), Cheng Liaoyi 程了一 (author of *Danfang ao lun* 丹房奧論), Wu Wu 吳 (author of *Danfang xuzhi* 丹房須知), and numerous unrecorded alchemists and medical groups. It can be said that from the 4th century to the 12th century, this knowledge group and its inheritance from the Tao-Ge School constituted the development path of ancient Chinese science and technology.

From the perspective of sociology, the Tao-Ge School maintained homology and continuity of knowledge through community members, including teachers, pupils, and families, which was very important for the integrity of the knowledge system. Furthermore, based on the renewal of knowledge and theory, the Tao-Ge School adopted the academic inheritance method of revising, annotating, and expanding classic books, especially medical books, such as *Shennongbencao* 神農本草, *Huangdi neijing* 黃帝內經, and *Zhouhoubeijifang* 肘後備急方. This process of knowledge inheritance and promotion was the main theoretical method of the Tao-Ge School. Its philosophy emphasized the importance of medicine in knowledge and the social function of medical assistance, which established the "Tao-Ge School" as a simple, practical, and standardized philosophical system (see Table 2).

In short, the Tao-Ge School was an academic tradition based on the practice of Daoist belief, which attaches importance to natural knowledge, technological invention, and knowledge rationalization. It comprises three basic academic characteristics: first, it highlights the social value of medicine; second, it emphasizes the accumulation and expansion of knowledge; and third, it focuses on the standardization and development of theory.

Table 2. The theoretical process of medical knowledge in the Tao-Ge School.

Representative Figure	Time Period	Ideology	Contribution
Ge Hong 葛洪	283–363	He focused on medical skills: "At the beginning of ancient times, Taoists also practiced medicine" (Ge 1988a, p. 228)	He wrote *Yuhanfang* 玉函方, *Zhouhoubeijifang* 肘後備急方, and *Baopuzi neipian* 抱樸子內篇.
Tao Hongjing 陶弘景	456–536	Offered the concept that "Daoist cultivation and medicine are before anything" (Tang 1986, p. 16).	Based on Ge Hong's *Zhouhoubeijifang*, he collected and supplemented the medical book, invented a distinguishing method by marking prescriptions with a red pen, and compiled *Zhouhoubaiyifang* 肘後百一方; he revised and supplemented types of medicine in *Bencaojing* 本草經 and proposed classifying drugs based on differences in their natural attributes (Ge 1988b, p. 2).
Yang Shangshan 楊上善	Sui and Tang dynasties	He interpreted the *Neijing*內經 from the doctrines and thoughts of Lao-Zhuang and Daoism, emphasized "Cultivating the body and mind with Dao" 以道怡性, and classified the *Neijing* into 18 categories with detailed annotations. (Gai 1997, p. 75)	He wrote *Huangdineijingtaisu* 黃帝內經太素 and *Huangdineijingmingtangleicheng* 黃帝內經明堂類成.
Sun Simiao 孫思邈	581–682	He advocated that "everyone can understand" medicine (Sun 1955, p. 6), contributed the slogan that "all things in the world are miraculous drugs," and developed a method of "classifying according to the properties of the drug" 方證同條, 比類相附 to organize medical records (Sun 1955, p. 97).	He wrote books, including *Qianjinyaofan*" 千金要方, *Qianjinyifang* 千金翼方, and *Tangxinbencao* 唐新本草, and developed the methods of "Twelve Lesser" 十二少 and "Twelve More" 十二多 for health preservation (Ren et al. 2020, pp. 7–10).

Table 2. *Cont.*

Representative Figure	Time Period	Ideology	Contribution
Hu Yin 胡愔	9th century	She emphasized the use of theory to interpret Daoist medical knowledge and technology: "According to the theory in the classics of medicine, first, understand the internal organs of the human body, then draw pictures. Find out the source of the disease, use the method of breathing to treat the disease, and obtain the methods of cultivation and medical theories" 按據諸經, 別為圖式, 先明臟腑, 次説修行, 並引病源, 吐納除疾, 旁羅藥理 (Hu 1988, p. 687).	She wrote *Huangtingneijing-wuzangliufubuxietu* 黃庭内景五臟六腑補瀉圖, *Huangtingneijingtu* 黃庭内景圖, and *Huangtingwaijingtu* 黃庭外景圖.
Wang Huaiyin 王懷隱	925–997	He indicated that "saving people and removing suffering" was the most important medical skill; he emphasized that "when doctors master the principle of treatment, they can cure the disease." At the same time, he paid attention to "collecting, revising, and sorting out traditional medical classics" 搜隱微, 詮括簡編 (Wang 1958, p. 1).	He edited *Kaibaochongdingbencao* 開寶重定本草 and wrote *Taipingshenghuifang* 太平聖惠方. To treat disease, he suggested to "first diagnose the pulse, and then describe the medication rules," and collect much knowledge of medical methods (e.g., *Neijing* 内經, *Nanjing* 難經, *Maijing* 脈經, *Qianjinfang* 千金方, and *Waitaimiyao* 外台秘要) (Fu 2008).
Su Song 蘇頌	1020–1101	He respected the medical theories and methods of Tao Hongjing and Sun Simiao. He said, "Tao Hongjing's *Guangbaifang* 廣一百方and Wang Tao's *Waitaimiyao* 外台秘要 are the most clear and learnable medical theory books"; "Sun Simiao's medical books have extensive knowledge. I selected the detailed outline and edited it again" (Su 1986, p. 700).	He edited eight medical books, *Shennongbencao* 神農本草, *Linshu* 靈樞, *Taisu* 太素, *Zhenjiujiayijing* 針灸甲乙經, *Suwen* 素問, *Guangji* 廣濟, *Beijiqianjinfang* 急備千金方, and *Waitaimiyao* 外台秘要, and wrote *Xiaobencaotujing* 校本草圖經.

3. Knowledge Demarcation of the Tao-Ge School

In the 4th century, the Tao-Ge School maintained the unique perspective: "Daoism has the scientific spirit of conquering nature" (Feng 1996, p. 3). In its epistemology, the Tao-Ge School had a strong tendency to understand and transform nature but was also ideologically conscious of its "demarcation" with traditional Chinese humanistic thought. This "knowledge demarcation" demonstrates the scientific and technological directions of the Tao-Ge School.

3.1. Naturalness: Demarcation with Confucian Humanism

Before Ge Hong, the Taoist knowledge tradition had not recognized the legitimacy of the official orthodox ethical ideology. Confucianism believed that the Daoist focus on developing nature knowledge and immortality technology often led to a practical way of life that contradicted Confucian ethics, so "the scholar-officials were ashamed to be involved in agricultural and commerce, and ashamed to work of craftsmanship" 士大夫恥涉農商, 羞務工技 (Yan n.d., p. 26). Ge and Tao proposed that Daoism attaches great importance to natural knowledge and craftsmanship technology as "necessary for Daoist practice" 修道所須 (Zhang 1988, p. 733), that is, Daoism has social value that Confucian ethics does not have.

Ge Hong defined the epistemological goal and direction of naturalization and scientization as "understanding the motion laws of all things in nature" 欲求物理in *Baopuzi neipian* 抱樸子內篇. He stated: "I just wanted to fully explain the truth of things. When the truth was understood, the things will become clear" 但欲盡物理耳, 理盡事窮 (Ge 1988a, p. 216).

The *wu li* 物理 can be interpreted as the law of all things in nature, that is, the essence and motion laws of nature and its entities. The so-called *yu jin wu li* 欲盡物理 means wanting to fully explain the truth of things.

Therefore, Ge Hong criticized Confucianism's limitations in knowledge as he believed, "Confucianism lacks exploration of natural phenomena and natural mysteries, but focuses on how to govern society" 不肯長奇怪, 開異途, 務於禮教 (Ge 1988a, p. 219). Further, Confucianism ignored the rational cognition of all things in nature and their motion laws and was often "limited to the knowledge of Confucian classics and the superficial understanding of things" 玩華藻於木末, 而不識所生之有本也 (Ge 1988a, p. 196) but did not acknowledge that "there is an infinite wealth of knowledge beyond Confucian classics" 夫五經所不載者無限矣, 周孔所不言者不少矣 (Ge 1988a, p. 201).

Like Ge Hong, Tao Hongjing also preferred to grasp the knowledge of astronomy, geography, biology, medicine, and technology from an epistemological perspective and was not interested in exploring Confucian classics. While he touched upon them, he did not research them in depth (Zhang 1988, p. 732). Regarding the style of empty debate in metaphysics that was popular among the scholars of the Southern dynasty at that time, he even called it *san dan* 散誕 (absurd) and *tan kong* 談空 (empty talk and no action) (Zhang 1988, p. 734). In fact, Tao Hongjing also perceived a demarcation of knowledge between Daoism and Confucianism: he believed that medical knowledge is related to human life, which is more important than Confucian ethics—"The Four Books and Five Classics, the etiquette and costumes of the army and the country, if there are any deviations in the detailed application, it can be understood that the harm is only reflected in the inappropriate deeds. But decoctions and medicines, once a mistake is made, it will involve life, it's so important, why not think carefully and proceed cautiously" 五經四部, 軍國禮服, 若詳用乖越者, 猶可矣, 止於事蹟非宜爾. 至於湯藥, 一物有謬, 便性命及之. 千乘之君, 百金之長, 何不深思戒慎邪 (Tang 1986, p. 17).

In the Tao-Ge School tradition, the development of Ge and Tao's epistemological thought can be traced along a continuous line. In the 8th century, Sun Simiao developed the philosophy of the Tao-Ge School to a new stage. He regarded medicine as the most important knowledge and offered the concept that "the top doctors should have extensive knowledge and technology" 大醫習業 (Sun 1955, p. 1). He emphasized that, in

addition to medical expertise, they also needed to learn traditional knowledge, including Confucianism, Daoism, Buddhism, astronomy, geography, and divination, to perfect the practice of medicine (Sun 1955, p. 1). In the 9th century, female Taoist Hu Yin 胡愔 wrote medical books such as *Huangtingneijingwuzangliufupuxietu* 黃庭內景五臟六腑補瀉圖, *Huangtingneijingtu* 黃庭內景圖, and *Huangtingwaijingtu* 黃庭外景圖. She transformed the mysterious cultivation technology of Daoism into practical medical and health care knowledge and actively promoted the progress of ancient Chinese medicine (Wang and Hao 1993, pp. 28–34). This demonstrates that under the influence of the Tao-Ge School, female Taoists could freely acquire knowledge, conduct in-depth research, and write books on medicine. Their remarkable work has influenced the studies in the field to a great extent. In the 10th century, Taoist Wang Huaiyin 王懷隱 followed the methods of Ge and Tao—he carefully collected and organized various traditional medical books, from which he compiled the important medical classic *Taipingshenghuifang* 太平聖惠方, which comprised various medical prescription books and numerous folk medical books in an omnibus that reflected the philosophy of the Tao-Ge School. In the 11th century, Su Song 蘇頌, who emphasized the social value of medicine, epitomized the thought of the Tao-Ge School. He believed that "medicine is the most important technology to save and help people" 救恤之惠, 無先醫術, and that "The most important thing to get rid of diseases and ensure health is the medicine of Dao" 驅沴淫, 救昏亂, 保壽命, 躋康寧, 無先於此道, which can "let the people live in a harmonious and clean environment, so that they can live a long and healthy life" 納斯民于壽康, 召和氣於穹壤. 太平之致, 茲有助焉 (Su 1986, p. 699). He was responsible for the compilation of *Bencaotujing* 本草圖經 and acquired significant medical knowledge and achievements from his predecessors.

Thus, the Tao-Ge School criticized and demarcated the academic ideology of Confucianism, which emphasized humanistic knowledge and ignored natural knowledge, whereas the Daoism tradition of science, technology, and craft knowledge reflected a natural and empirical epistemological orientation, which has been fully affirmed and has persevered.

3.2. Positive Action: Demarcation with Daoist Metaphysical Thought

As is well known, Daoist beliefs and practical concepts have a rather complex relationship with Daoist philosophy. Daoism's cosmology, life theory, and epistemological thought are closely related to Lao-Zhuang's. However, the scientific and technological practices of Ge and Tao demonstrated practical characteristics with interests that differed from the metaphysical thought and spiritual temperament of Daoist philosophy.

3.2.1. Advocating the Spirit of Proactive Acquiring of Knowledge

The original meaning of *wu wei* 無為 (refraining from activity contrary to nature) advocated by Daoism does not refer to passive inaction but conforms to nature. However, the concept of *wu wei* tends to discourage the active understanding and transformation of nature. The metaphysics of the Wei and Jin dynasties have developed into features of clear, sparse, and empty thinness. In this regard, Ge and Tao criticized the metaphysical speculation at that time and offered positive, promising principles of craftsmanship practice.

Ge Hong advocated that Taoist beginners should spare no effort, dare to take risks, collect and refine medicine in the mountains, and actively use farming, grazing, and business to obtain the funds and wealth needed for alchemy and pharmacy (Ge 1988a, p. 244). Tao Hongjing pointed out that the metaphysical speculative style of the literati and officials in the Southern dynasty was *san dan* 散誕 (absurd) and *tan kong* 談空 (empty talk and no action); instead, he emphasized that cultivators should actively acquire "all kinds of astronomy, calendar, arithmetic, and geography, natural history, medical knowledge, and technology" (Zhao 1988, p. 242). Later generations of Daoist alchemists also insisted that "a Daoist alchemist must acquire the knowledge and technology of astronomy, geography, climate, and chemical smelting" 修丹之士, 須要上知天文, 下明地理, 洞達陰陽, 窮通爻象; 並節氣休王, 日時升降, 火候進退, 鼎爐法則 (Meng 1988, p. 220) and that they "must know

the motion law of all things and learn lots of technical books" 必須精祥物理, 廣博方書 (Jin 1988, p. 112). They even shouted the slogan, "the true method of actively transform nature" 有為之真法:

> Laozi taught the *Dao De Jing*, and Sakyamuni founded Buddhism. They all only taught the truth of showing the true nature of human beings through inaction. Life and death go hand in hand. They only preserve their true nature, keep their minds quiet and empty, and ultimately cannot make their bodies live forever. Competing to make alchemy, so that people can live forever, the material in the body is constantly alive, and become an immortal. This is the true method of actively transform nature.
>
> 老子述五千文, 釋氏演三乘教, 只説無為見性之理, 生而有死, 唯全其性, 作虚明之神, 終不能堅固其形.爭似還丹, 生前不死, 不息内質而獲非飛仙, 乃是有為之真法. (Meng 1988, p. 218)

The slogan "the true method of actively transform nature" posed by Daoist alchemists was the opposite of the spirit of inaction and liberation of Lao-Zhuang and Buddhism. It represented the spiritual embodiment of the Tao-Ge School that actively recognized nature.

3.2.2. Affirmation of the Knowledge Inheritance Function of Words

To some extent, both Lao-Zhuang and Buddhism's philosophies ignored the cognitive function of words regarding the external world and specific things. The metaphysics of the Wei and Jin dynasties drew on the cognitive methodology of Lao-Zhuang and Buddhism, proposed that "words are not expressing the meaning of things" 言不意 (B. Wang 1986, p. 544), and tended to despise and deny the cognitive function of words. In this regard, the representatives of the Tao-Ge School raised objections. They insisted that "words" functioned to recognize all things in nature, accumulating and disseminating knowledge, and should not be discarded.

Ge Hong believed that words are indispensable tools for human beings to understand and grasp the actual world. He pointed out that "The bamboo trap can be discarded, but if the fish is not obtained, there cannot be without the trap; words can be discarded, but if Dao has not been practiced, there cannot be without words" 荃可以棄而魚未獲, 則不得無荃; 文可以廢而道未行, 則不可無文 (Ge 1988c, p. 326). Thus, Ge Hong affirmed the cognitive function and value of words. Tao Hongjing was more deeply aware of the function of words for knowledge generation and dissemination. He believed that words were not only the main tool for human beings to describe "knowledge" but also an indispensable carrier for recording, accumulating, and creating "knowledge".

> In the Shennong era, there were no words; during the era of the Yellow Emperor, words were invented, so there was the *Shennong bencao jing*; since then, a large number of knowledge classics and ideological theories have appeared, which are inherited only by words 神農之時, 未有文字, 至於黃帝書記乃興, 於是神農本草, 列為四經.三家之説, 號有損益, 豈非隨時適變, 殊途同歸者乎. (Tao 1958, p. 6437)

It is evident that Ge Hong and Tao's knowledge generation and inheritance functions of words were different from the traditional concepts of Lao-Zhuang and Buddhism in that they actively affirmed and praised the role of words.

3.3. Advocating the Spirit of Technology's Craftsmanship and Creativity

Contrary to the belief that metaphysics, Confucianism, Buddhism, and other humanistic traditions despised or even belittled technology, the Tao-Ge School reflected a strong spirit of advocating technology. Ge Hong affirmed and respected the value of *shu* 術 (technology), and his attitude was very clear. He stressed that in Daoism, whether the goal is to cultivate and become immortals, or to cultivate the body with drugs, in daily life or production activities, we must rely on *shu shu* 數術 or *fang shu* 方術 (technology of immortality and alchemy) (Ge 1988a, p. 231), and proposed the slogan "the various alchemy and medicine technologies can promote immortality" 藉衆術之共成長生 (Ge

1988a, p. 216). From an ethical perspective, Ge Hong also represented "technology" (*shu* 術) positively: "sage is not only the exclusive name of Confucian sages, but also those who grasp all kinds of knowledge and skills can be called sage" 聖者人事之極號, 也不獨于文學而已矣 (Ge 1988a, p. 215). For example, those who are good at medicine can be called sages of treating diseases 治疾之聖, those who are good at mechanical manufacturing can be described as sages of machinery 機械之聖, those who are good at woodworking technology can be described as sages of woodworking 木工之聖, those who are good at painting can be called painting sages 畫聖, and so on. Ge Hong's view of sages was very different from that of traditional Confucian and metaphysical values, which fully reflected his admiration for the value of technology.

Tao Hongjing affirmed practice activities that promoted human technology. He praised Shennong 神農 and regarded him as the founder of the ancient Chinese technological civilization:

> Shennong governs the world with Dao. He invented Bagua 八卦 and Yixue 易學 to communicate the relationship between Cosmos-man; he taught the people to engage in farming to eliminate the drawbacks of killing; medicines are used to treat diseases and save the people. These three achievements of Shennong have been passed down for a long time and will be famous for future generations 神農氏之王天下也, 畫八卦, 以通鬼神之情; 造耕種, 以省殺生之弊; 宣藥療疾, 以拯天傷之命.此三道者, 曆衆聖而滋彰. (Tang 1986, p. 11)

Therefore, in Tao Hongjing's view, Shennong 神農 was the original inventor of farming and medicine; thus, his historical achievements were equivalent to those of the ancient sages Huangdi 黃帝 and Zhuanxu 顓頊. Notably, Tao Hongjing compared the human body during the practice of cultivation to utensils used during pottery casting, a quintessential practical activity of technology. "Cultivation is the most superb smelting technique, reflecting the ultimate principle of material change" 鑄煉之事極, 感變之理通 (Gao 1986, p. 337). In addition, in relation to medical practice, he proposed that "everything in the universe can be used by people" 蓋天地間物, 莫不為天地間用 and believed that "all things in nature can be used to make medicines" (Tang 1986, p. 16). In the Tang and Song dynasties, Daoist alchemists also inherited Ge and Tao's spirit of technology practice. They were self-confident and believed that they were "technicians who have Dao's knowledge" 有道術士 (Jin 1988, p. 113). With superb craft technology, they could control all things and the law of motion in nature, so as to refine them into elixirs and medicine to save the people.

In summary, the Tao-Ge School demonstrated its independent scientific and technological spiritual characteristics through "knowledge demarcation" with Confucianism, abstruse Dao, and other humanistic thought (i.e., pursuing natural knowledge and emphasizing technological practices). It can be said, against the background of politics, ethics, and humanistic thought in the Chinese tradition, that the Tao-Ge School demonstrated a unique scientific spirit in its pursuit of natural knowledge and technological creation.

4. Theoretical Thought of the Tao-Ge School

Historically, Ge and Tao recognized the positivity and accuracy of knowledge and pursued its overall principles. Historical data indicate that the representatives of the Tao-Ge School consciously speculated about and practiced the theorization of knowledge and rational cognitive methods. It can be said that rationalized cognition is also one of the main academic characteristics of the Tao-Ge school.

As mentioned, Ge Hong was the first to propose the concept of *yu jin wu li* 欲盡物理 (understanding the motion laws of all things in the world). *Wu li* 物理 means the essence of nature and motion laws of all things (*li*理). In *Baopuzi zhili* 抱樸子至理, Ge Hong describes the concept of *zhi yin* 知隱 (know secret knowledge), "people only see the surface of things, but often do not know the secret essence of things" 世人不能知其隱者, 而但見其顯者, but that the Taoists will "recognize the law and essence of things" 為乎無為, 以全天理爾 (Ge 1988a, p. 189). This "yin" means the *Dao* 道 and *li* 理 (motion laws of all things) hidden behind the appearance of things. Although Ge Hong attached importance to experience

and technology, he also began to pay attention to inquiry and exploration of *wu* 物 (all things in the world) and *li* 理 (motion laws of all things). He believed people should not only explore "the law of daily life" 尋常咫尺之近理, 人間取捨之細事 (Ge 1988a, p. 192) but also know the motion laws of all things in the universe: "As long as you grasp the law of the universe, you can grasp the motion laws of all things at the same time." 苟得其要, 則八極之外, 如在指掌; 百代之遠, 有若同時. 不必在乎庭宇之左右, 俟乎瞻視之所及, 然後知之也 (Ge 1988a, p. 178).

It is evident that Ge Hong thought deeply about the cognitive method and its value. Consequently, he criticized the phenomenon that "people believed in divination, sacrifice, and witchcraft to cure diseases and do not believe in the medical skills of good doctors". 寧煞生請福, 分蓍問祟, 不肯信良醫之攻病, 反用巫史之紛若 (Ge 1988a, p. 190). Tao Hongjing considered and explored rational cognition and the theorization of in-depth knowledge and even constructed an initial set of rational cognition methodologies.

First, it is necessary to grasp the experience and knowledge fully and accurately. He believed that to "understand and grasp the truth of nature, we must possess more comprehensive and sufficient knowledge; we cannot draw conclusions based on fragmentary and partial knowledge. More importantly, we must test the detailed empirical or experimental knowledge, rather than relying on subjective imagination and arbitrary speculation" 天地間事理, 乃不可限以胸臆尋之 (Tao 1988a, p. 584).

Second, original knowledge is required to analyze empirical knowledge. Tao Hongjing believed that if we want to form logical and systematic knowledge, we must analyze the relevant knowledge materials by "observing the similarities and differences, distinguishing between right and wrong, seeing inside and outside, and knowing whether there is or not" 察同異, 別是非, 見內外, 知有無 (Gui 1988, p. 677). Thus, we can reasonably classify them on this basis. To this end, Tao Hongjing created a set of scientific classification methodologies: First is that the historical view of classification changes at any time and that new knowledge classification is based on changes in historical times and cognitive levels. Second is the dialectical classification methodology, which posits that classification should follow the principle of combining universality and particularity and analyze each specific matter. Third is the simple and practical view of the classification function, which states that knowledge classification should be based on the principles of practicality and simplicity. On this basis, people can establish a knowledge structure system of "consistent logic and standard knowledge style" 通立定格, 共為成准 (Ge 1988b, p. 2).

Finally, it is necessary to grasp knowledge materials logically to create a theoretical knowledge system. Tao Hongjing used a vivid cognition metaphor to subtly illustrate how to upgrade from perceptual cognition to rational cognition:

> The construction of the classical theory and knowledge systems can be compared to spinning and weaving. The warp and weft must be evenly distributed, connected and integrated into one; otherwise, the work of trying to theorize knowledge will end up like a failed weaving process, which cannot form true theoretical knowledge 夫經之為言, 徑也.經者, 常也, 通也.謂常通而無滯, 亦猶布帛之有經矣, 必須銓綜緯緒, 僅乃成功.若機關疏越, 杼軸乖謬, 安能斐然成文. (Tao 1988b, p. 646)

Tao Hongjing's metaphor of "weaving cloth" dovetails with Francis Bacon's metaphor of "bees", who represent the "true ancestor of the whole experimental science" in modern times. "Real philosophical work is similar to bees; it is neither wholly nor primarily dependent on the power of the mind, nor everything in memory that has been learned from natural history or experimentation with mechanisms, but is processed and transformed in understanding" (Francis Bacon 1955, p. 126). Marx commented in this regard: "Science is the science of experiments, and the scientific method is to use rational methods to organize perceptual materials. Induction, analysis, comparison, observation, and experiment are rational methods and important conditions" (Marx and Engels 1958, p. 175). Therefore, the scientific epistemological significance of Tao Hongjing's metaphor of "weaving cloth" lies in refining and transforming perceptual-experiential knowledge into a universal and holistic

"theory" and knowledge system. It is worth mentioning that Tao Hongjing's cognitive metaphor predates Bacon's "bee" metaphor by more than 1100 years.

Historically, Ge and Tao's rational cognitive methods and philosophy have been inherited and perpetuated over generations of the Tao-Ge School. For example, Sun Simiao's medical research embodied this characteristic of theoretical thought. In his books *Beijiqianjinyaofang* 備急千金要方 and *Qianjinyifang* 千金翼方, although medical prescriptions occupy most of the pages, nearly all prescriptions are organized per medical theory. In medical treatment, Sun Simiao also astutely summarized medical theories. He summarized the methods of "zangfu bianzheng fa" 臟腑辨證法, "twelve lessers" 十二少, "twelve mores" 十二多 for health preservation, "classified according to the properties of the drug" 方證同條, 比類相附, and developed the method of "nourishing the fetus" 養胎 (Ren et al. 2020, pp. 7–10). Although the Tao-Ge School was already declining in the 12th century, Wuwu 吳 (a Taoist of the Outer Elixir 外丹 School in the Southern Song dynasty) still proposed the concepts of "the law of nature" 自然之理: "by understanding the law of nature one can know the essence of things" 悟理得道 (Wu 1988, p. 285). He advocated that people should actively explore the essence of nature—"The universe contains Dao of nature, all things contain the law of nature. If you don't know Dao and the motion laws of all things, you can't know the essence of all things" 天下有自然之道, 萬物有自然之理.不得於理, 物且不通, 而況道乎; "Why the classics written by FuXi and ShenNong can be spread in the world, because their books contain the ultimate law of the universe. People can understand this truth only by practice" 伏羲神農之書, 既傳於世, 豈固複有隱乎? 惟心契於道, 行合於理者, 見之自然悟理而得道. Scholars "need to learn all kinds of alchemy, cultivating Daoism knowledge, and skills, then they can obtain the Dao" 悟理而得道, 予當披尋丹經百數十家, 言雖不同而理實一貫 (Wu 1988, pp. 282–83). Thus, advocacy for rational cognition and the continual development of knowledge and theory is a consistent tradition of the Tao-Ge School.

In summary, the Tao-Ge School contains a valuable spiritual tradition of scientific rational cognition. Scholars of the past were not only satisfied with the inheritance of empirical knowledge and technology but also committed to the overall theoretical construction of knowledge. In the history of ancient Chinese science and technology, the Tao-Ge School embodied the spirit of traditional Chinese rational cognition and was undoubtedly integral to their development.

5. Conclusions

The research has demonstrated that the Tao-Ge School (4th–12th centuries AD), which was in existence for more than 800 years, first established a scientific research paradigm with a Chinese cultural temperament and was an iconic school of scientific and technological activity in the Middle Ages. The academic concepts and methodological characteristics of the Tao-Ge School can be roughly summarized into three points: (1) the primary goal was to understand and transform the world of nature, reflecting a different epistemological perspective than that of the traditional school of ancient Chinese humanities, (2) it reflected a practical spirit that advocated for and affirmed the value of technology, which was contrary to the perspective held by the traditional humanities school and depreciated its value, and (3) it promoted practical action with rational cognitive thinking and continual theorization of knowledge and was not simply limited to the inheritance of empirical knowledge and practical skills.

Historically, the Tao-Ge School exhibited a complex relationship and ideological tension between religion and technology in ancient China. Unfortunately, the scientific research program initiated by the Tao-Ge School was not embraced by subsequent generations. This may have been due to the extensive gap in the cognitive path between empirical research and theoretical research in Chinese mainstream traditional culture or, perhaps, to barriers in the dissemination of knowledge achievements or interruptions in the inheritance of knowledge. It remains unclear. However, if we systematically analyze existing knowledge of the Tao-Ge School, we can identify the obstacles and factors in the development of

ancient Chinese science and technology that have been obscured by the sands of time. Such exploration opens a new prospect for understanding the relationship between religion and science in ancient China.

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