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(Review Article)

Interpretation of collaborative virtue ethics of scientists

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Abstract

This article argues for the integration of collaborative virtue ethics into modern life, highlighting its foundation in the practices of contemporary science. It posits that the respect commanded by modern science is not due to a superior objective foundation, but to its embodiment of human synergy based on weak rationality and moral virtue. Drawing on Polanyi's concept of "coordination by mutual adjustment," the article illustrates how scientific progress results from the collective efforts and consensus of many individuals. This collaborative ethic, historically rooted in the evolution of scientific research from individual endeavors to organized teamwork, underscores the importance of mutual respect and cooperation. The discussion emphasizes that fostering team spirit, nationwide collaborative efforts, and valuing collective contributions are essential for addressing complex challenges in modern society.

Keywords: Collaborative Virtues; Scientific Cooperation; Team-Based Accomplishments; Ethical Virtue in Science; Scientific Evaluation Mechanisms; Goal Succession; Intergenerational Cooperation; Collective Contributions; Synergistic Integration; Scientific Innovation

1. Introduction

Judging from the nature of modern science, science is respected not because it has a stronger objective foundation and more reliable objective methods, but because it demonstrates synergy to the maximum extent and is a model of human synergy. This synergy does not come from strong rationality. On the contrary, it is based on weak rationality, which embodies more of a certain moral virtue. [1] Polanyi points out that collaboration among scientists “results from each scientist constantly adapting his efforts to the latest results of other scientists to date. We might call this collaboration through independent initiatives Coordination by mutual adjustment - this coordination is achieved because each independent initiative considers the other initiatives operating in the same system. "Scientific judgment is not the opinion held by any single mind, but it includes thousands of fragments held by many individuals, and each individual relies on the chain of consensus to indirectly recognize the evaluation of others. It is the chain of consensus that connects an individual to everyone else. A chain of overlapping neighborhoods connects each other.” [2] Polanyi’s view, although somewhat idealistic, largely reflects the collaborative nature of contemporary science.

Judging from the history of scientific development, scientific research before the 16th century was mainly based on individual exploration, and cooperation was only an accidental phenomenon. In 1560, the Italian physicist G. Porta founded the "Society for the Secret Study of Nature" in Naples, which is considered the first academic organization of natural science in modern history; in 1662, the establishment of the Royal Society marked the formation of scientific institutionalization; Germany established the Berlin Academy of Sciences in 1700, Russia established the St. Petersburg Society in 1724, and France had 37 local academies of science in 1760. With the gradual improvement of the degree of organization of scientific research, science and industry became integrated, universities and colleges responsible for the function of science and technology education gradually raised, and the scientific community became mature. [3] Since the 20th century, collaborative research among scientists, scientific research institutions, and even national

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governments has become the mainstream. Correspondingly, the virtue of collaboration has become an essential quality for contemporary and future scientists.

2. Build Team Spirit

Different scientific activity individuals in the modern scientific community are brought together by factors such as common interests, karma, and interests. How different individuals with specificity come together is a difficult problem in the collaboration of this community: they must be individuals within it, even though it is tough. A reasonable division of labor is not a maverick of individual scientific activities, individual members of a scientific activity community must transcend the threshold of "self-interest" and no longer be limited by whether they can realize themselves to the maximum extent, but take thinking and interests of the community as the main consideration. [4] This is not only a rational choice for the steady and long-term development of scientific and technological innovation, but also an inevitable requirement for building a scientific and technological innovative ecosystem. In a scientific community, whether a leader or a team member, only by carrying forward and condensing a high degree of collaborative virtue can we avoid a simple "big platter" and "match up", form complementary advantages between different innovation entities, and break the "island effect" ", avoiding the “barn-style” and “chimney-style” scientific research organization models, causing “physical collisions” and “chemical reactions” between different innovation entities [5], truly promoting cross-disciplinary integration and truly realizing collaborative innovation.

In 1945, the Royal Swedish Academy of Medicine decided to award that year's Nobel Prize in Biology and Medicine to Flory, Fleming, and Chain. In the award speech, they called the discovery of penicillin "the most valuable contribution in the history of modern medicine." and emphasized that this was "an outstanding example of collaboration between different scientific methods for a common goal." In the summer of 1928, Fleming discovered that the secretion of a green mold could effectively kill the vicious Staphylococcus aureus. The results were published in the Quarterly Journal of Experimental Pathology and called on more scientists to participate in this research work. Beginning in 1939, under the auspices of Flory, a group of enthusiastic scientists voluntarily formed an experimental research team, which enabled penicillin to enter clinical application and save countless patients facing death threats. [6] Just as the Harvard family motto comments, collaboration creates incomparable glory. One statistics made by American science historian Harrict Zuckerman (1937-) shows that from 1901 to 1972, a total of 286 scientists won the Nobel Prize, of which 185 were successful in cooperating with others, accounting for 64.7% of the total, and the closer the year, the higher the proportion of collaboration results. In the first 25 years (1901-1925), winners of collaborative research accounted for 41% of the total number of awards; in the second 25 years (1926-1950), this proportion increased to 65%; in the third 25 years (1951-1972), this proportion reached 79%. Wu Tong and other scholars' statistics on the number of authors of papers in the authoritative international physics magazine "Physical Review" show that since the 1930s, the proportion of collaborations has increased year by year, and the number of collaborators has also shown an upward trend. In 1991 The annual cooperation ratio is as high as 85%. [7] Gao Fangyi’s statistical analysis of the scientific research cooperation of highly cited Chinese scientists shows that among the 912 highly cited papers, collaborative papers accounted for 93%, of which 23.1% were collaborations with 2 people, 20.6% were collaborations with 3 people, and 4 Cooperation with one person accounts for 11.5%, cooperation with five people accounts for 8.1%, and cooperation with more than five people accounts for 25.7%. [8] Scientific research collaboration has become an irreversible trend, and there is a positive correlation between scientific research output and scientific research cooperation.

In 1958, a scientific research team composed of the Institute of Biochemistry and the Institute of Organic Chemistry of the Chinese Academy of Sciences (CAS), and the Department of Chemistry of Peking University launched the synthetic insulin project. In the next 8 years, 8 scientific research units officially participated in this project, with about 800 scientific researchers. The various research groups divided their work without separation, exchanged personnel and allocated resources according to scientific research needs, and wan the "World Championship" based on the spirit of collaboration. In 2015, when commemorating the 50th anniversary of artificially synthesized insulin, Bai Chunli, then president of CAS, wrote a message in which he particularly appreciated the teamwork spirit reflected in the research process of the artificial total synthesis of crystalline bovine insulin. Quantum information technology is the focus of international competition. The quantum science experimental satellite "Mozi" launched by China for the first time in the world is the product of collaborative innovation. Academician Pan Jianwei said at the 2019 Pujiang Innovation Forum that in 2017, the University of Science and Technology of China (USTC) established the Quantum Innovation Research Institute on the basis of integrating the Collaborative Innovation Center of the Ministry of Education and the Center of Excellence of CAS. The main purpose is to conduct “chain layout” comprehensive research in the quantum field, integrating the relevant advantages of our institute to cooperate with universities, scientific research institutes, and related enterprises across the country (as of September 2020, the main participants in the construction of the institute are 9 units from CAS and 10 units outside CAS, more than 1,800 scientific researchers of various types, including more than 560 with senior professional titles), which can create conditions and lay the foundation for the formation of a professional laboratory within the national lab. The ultimate goal is to achieve the deployment of the entire chain from basic research to the market through interdisciplinary and collaborative innovation models (in the quantum field). [9] Multidisciplinary and comprehensive national laboratories have become inevitable for high-tech innovation and development.

3. Nationwide Efforts to Tackle Key Problems

The so-called nationwide system is a special institutional arrangement that concentrates resources within the boundary to meet the country's major needs in specific fields. What needs to be noted here is that although collaborative social virtue appears in the form of an institution, individual collaborative virtue is still its premise and foundation. Different from the traditional nationwide system, which mainly originated from planned economy thinking, the new system highlights the coordination between the market and the government, changes from product oriented to commodity oriented, from a single subject to multiple participation, and from one-time projects to regular special projects. Specifically in the field of science and technology, the new nationwide system is embodied in the construction of a national innovation system (the theoretical basis of which is the national innovation system theory and innovation cluster theory). Through the policy guidance of the government innovation decision-making department, based on the cooperation of universities, scientific research institutions, financial institutions, intermediaries and enterprises, with innovative enterprises as the core, technology transfer as the means, and the construction of collaborative innovation platforms as the path, we will focus on the great coordination and great alliance among various innovation subjects, elements, units, and systems carried out for scientific and technological innovation projects of strategic value to form high-quality and efficient innovation clusters and "technology-economic" collaborative network.

The nationwide system has been widely adopted by countries around the modern world in the field of science and technology. In 1928, the former Soviet Union established an aerodynamic laboratory in Leningrad. In 1933, this research institution had more than 200 scientific and technical personnel and successfully developed the first liquid rocket. In 1937, Hitler established a rocket research center and organized more than 2,000 scientific and technical personnel from different professions to conduct research. Five years later, it was put into use on the battlefield. In 1942, the United States mobilized a total of 150,000 scientific and technological personnel from different disciplines to develop an atomic bomb. It took three years to complete the world's first atomic bomb. A total of 4 million people participated in the development of the 1961 Apollo mission, which enabled the United States to realize the moon landing plan in 1969. After the industrial revolution, the governments of contemporary Western developed countries have been pursuing small governments and minimizing intervention in the market, but they attach great importance to the role of government in scientific and technological innovation. In 2009, the Obama administration released the "A Strategy for American Innovation: Securing Our Economic Growth and Prosperity" to deploy and implement the national innovation strategy. It was updated twice in 2011 and 2015, emphasizing the importance of the U.S. government in investing in the basic elements of innovation, who plays a key role in improving the market-oriented mechanism for technological innovation and breaking through national priority development areas. On the basis of continuing the original science and technology plan, the Trump administration has adopted measures such as tax cuts, introducing high-end talents, and strengthening infrastructure construction to significantly increase investment in key priority areas to support and ensure the "America First" strategy. [10] Although the science and technology strategies of the United Kingdom, Germany, Switzerland, Japan, South Korea, Singapore, Israel and other countries have their own characteristics, they are basically similar, which is establishing a nationwide system to seize the commanding heights of science and technology has become the common experience and practice of the contemporary world's science and technology powers.

"Two bombs, one satellite" is a successful example of my country's traditional science and technology national system. On November 17, 1962, the Central Committee established a special committee with Zhou Enlai as director and seven vice prime ministers and seven ministerial leaders as members. The Central Special Committee coordinated CAS, national defense scientific research institutions, industrial departments, universities, and local scientific research forces to pool wisdom and overcome various difficulties, effectively promoting the success of nuclear weapons development and testing. In December 1983, in the early days of Chinese Economic Reform, the central government decided to include the collider project as a national key construction project. 14 ministries and commissions established a coordination group for engineering non-standard equipment. The engineering equipment conference held in 1984 was attended by representatives from 68 units. There are 111 trial production or production agreements signed, including 44 from the Ministry of Machinery Industry, 34 from the Ministry of Electronics Industry, 9 from the Ministry of Nuclear Industry, 11 from CAS, and 13 from other ministries and academies. [11] In the next four years of research and development, tens of thousands of scientific researchers, workers, cadres, and PLA officers and soldiers from hundreds of research institutes, universities, and factories across the country participated in this project. In 1986, China's manned spaceflight was included in the "863" plan. In 1992, it was officially approved by the Central Committee and was put under special management under the direct leadership of the Central Special Committee. The manned space industry is described as an enterprise where "an arrow for a thousand, a gun for ten thousand." The manned space industry now consists of astronauts, space applications, manned spacecraft, cargo spacecraft, space laboratories, space stations, and optical cabins. It consists of 14 systems with extremely high technological content, including the Long March 2F, the Long March 5B, the Long March 7 launch vehicle, the Jiuquan launch site, the Hainan launch site, the measurement and control communications and the landing site. The engineering office needs to coordinate more than 110 major research and development units and more than 3,000 collaborative supporting units. In the past 10 years, the Aerospace Environmental Control and Life Protection Team of the Astronaut Scientific Research and Training Center alone has completed the development of more than 2,500 products for rendezvous and docking missions and more than 7,000 products for space station missions. [12] In the manned space project, market-oriented operations and military-civilian integration have been fully utilized and developed.

The development of China's standard EMU involves 68 academicians, more than 600 professor-level senior engineers, more than 200 research institutes and tens of thousands of engineering technicians from 25 universities, 11 scientific research institutes, 51 national laboratories and engineering research centers across the country. The Three Gorges Project is the result of decades of research by hundreds of thousands of scientific and technical personnel across the country, overcoming scientific and technological difficulties, and solving many of the world's major problems in the design, construction, equipment manufacturing, installation and commissioning of hub projects and power transmission and transformation projects. The manned submersible is a complex system engineering, involving the integration of materials, manufacturing, structure, hydropower, machinery, hydraulics, energy, acoustics, control, life support and other disciplines. The "Striver" project group consists of 19 projects It has continued to introduce and bring together high-tech capabilities, forming a manned deep-diving technology "national team" composed of more than 100 institutions and nearly 1,000 scientific researchers. UHV plus and minus 800 kV UHV DC transmission technology is a collaborative effort of more than 160 scientific research departments, universities, and equipment manufacturing units to overcome world-class problems such as insulation characteristics, electromagnetic environment, equipment development, and testing technology under ultra-high voltage and ultra-large current. Nuclear power is the most complex energy system in the world. The global collaborative innovation R&D platform established by "Hualong One" is composed of R&D and design units such as China National Nuclear Engineering and Nuclear Power Institute, and 75 universities and scientific research institutions including Tsinghua University and Harbin Institute of Technology, as well as 14 foreign institutions and universities, with a scientific research team of more than 1,000 people; the research and development of "Guohe No. 1" has successively organized 605 domestic scientific research institutes, equipment manufacturing companies, and universities, with 31,853 scientific researchers. With the further advancement of Chinese-style modernization, more and more major scientific and technological projects need to be completed through a new national system.

In the process of harnessing an entire country's efforts to tackle key problems, special attention must be paid to avoiding the Ringelmann effect. French scientist Maximilien Ringelmann (1861-1931) used a tug-of-war experiment to test and found that the effort exerted by a group of people is often less than the sum of the efforts made by individuals acting alone, and then concluded: When When people participate in social collective activities, their individual contributions will gradually decrease as the number of people increases. He called this phenomenon "social laziness", also known as "social escape", and academic circles also called it the "Ringelmann effect". In the design of the Hong Kong-Zhuhai-Macao Bridge Island Tunnel, the chief designer Lin Ming proposed a "semi-rigid" longitudinal design idea for the deeply buried section that had never been used before. At the expert consultation meeting, the Dutch representative of the partner directly rejected it, the project department cooperates with universities and scientific research institutions such as Tsinghua University, Tongji University, CCCC Highway Constructions Co., Ltd, CCCC Fourth Engineering Research Institute, Japan Civil Engineering Consulting Co., Ltd., and invites 5 domestic and foreign professional research institutions to carry out parallel analysis and calculations. At the construction drawing design review meeting, experts and designers argued fiercely, and the review ended with an extremely rare "disapprove". After a full year of debate, the construction drawings were finally completed and approved. In addition, the scientists also properly handled a series of contradictions and conflicts in the legal, institutional, cultural and technical standards of Guangdong, Hong Kong and Macao. [13] In 1976, the Qinghai-Tibet Plateau scientific expedition team consisted of more than 400 experts, covering more than 50 branches of geoscience, biology, agriculture, and almost all subjects involving natural conditions. At the beginning, the staff came from various units, including research institutes and universities. Even though the majors were the same, the research methods were different, so the work was relatively detailed and slow. After two years of hard work, four professional teams were gradually formed, which was summarized by the Qinghai-Tibet team as the "Qinghai-Tibet Effect", which means the cohesion effect of exploring the mysteries of nature, the mutual penetration effect of different disciplines, the catalytic effect of the emergence of talents, and the ever-expanding society effect. [14] The Ringelmann effect in the national system needs to be carefully studied and summarized.

4. Respect Team Contributions

In recent years, the "three-person rule" of the Nobel Prize (that is, a prize can be shared by up to three people) has been controversial. Some commentators jokingly called it "three people must be unfair", and the team's contribution is not fully respected. In March 2013, Horton, a virologist at the University of Alberta in Canada, was awarded the Gairdner Prize (known as the bellwether of the Nobel Prize) in recognition of his contribution to the discovery of hepatitis C virus and blocking blood transmission. Horton But he refused to accept it because the Gairdner Award was also a "three-person rule" and was not awarded to two important partners with whom he had worked closely for seven years. In contrast, in September 2007, the Gruber Prize, the highest award in astronomy, was awarded to the Nova Astronomy Project of Lawrence Berkeley National Laboratory in the United States and the supernova research group of the Australian National University. All 51 people from the two institutions won the award. [15] This approach quickly received widespread praise from scientists.

Fundamentally speaking, respecting the contribution of the team must be supported and guaranteed by the virtue of scientists. After Darwin became famous, he wrote a letter of thanks to some scientists: "I know very well that without the rich data collected by numerous esteemed observers, my book would not have been completed at all, and even if it had been written, it would not have been possible. will leave any impression in people's minds, so I think the honor should mainly be attributed to them. "Qian Xuesen has said many times, "It is unscientific to call me the 'Father of Missiles' because missile satellite work is 'big science'. It was made possible by the concerted efforts of millions of people, and there are hundreds of people in charge of science and technology. How can there be any 'father'?" [16] In her speech after winning the Nobel Prize, Tu Youyou said, "Without the team spirit of everyone's selfless cooperation, we would not have been able to contribute artemisinin to the world in the short term." "The discovery of artemisinin was not the work of one person. "Achievements are the result of the team's joint efforts." In subsequent interviews, she always puts the team's contribution first and always emphasizes that this is a multi-disciplinary, multi-institutional, multi-field collaboration. collective results. These outstanding scientists don't care who comes out on top, they just care about how to work together better.

On the premise of promoting the virtue of collaboration in the scientific community, respecting the contribution of the team also requires a scientific evaluation mechanism, and this evaluation mechanism must maintain and support the formation and inheritance of the virtue of collaboration among scientists, promote the promotion of team collaboration spirit and the sustainability of the collaborative innovation ecosystem. healthy growth. In scientific research evaluation, the issues of emphasizing short-term evaluation over long-term evaluation, emphasizing individual evaluation over team evaluation, emphasizing paper evaluation over project cooperation evaluation, and emphasizing the number of achievements over actual contribution evaluation have attracted widespread attention from the scientific and educational circles and have become a key issue in the reform of the evaluation system. the key of. The evaluation of scientific and technological innovation teams should focus on cooperatively solving major scientific and technological problems, conduct a comprehensive evaluation, and focus on evaluating the cutting-edge nature of its research and development direction, interdisciplinary nature, employment and incentive mechanisms, collaborative cooperation status and capabilities, and team culture construction (identification sense, cohesion and belonging), etc.; it is necessary to use static indicators to reflect the foundation, current situation and strength of the team, and to use dynamic indicators to reflect the potential, trends and prospects of innovative development; it is necessary to reflect the team leader as the leader of team development. , organizers, and coordinators, while also respecting and recognizing the actual contributions of all team participants, and eliminating false names without substantial contributions.

In line with the individual evaluation of scientific and technological talents, team evaluation should reflect the principle of classification on the premise of highlighting "problem solving and pursuit of excellence" as a whole. Teams mainly engaged in basic research should focus on evaluating their proposing and solving major scientific problems. original ability, scientific value, academic level and impact of the results, etc.; for teams mainly engaged in applied research and technology development, focus on evaluating their technological innovation and integration capabilities, independent intellectual property rights and major technological breakthroughs, achievement transformation, and impact on the industry. actual contribution to development, etc. For the scientific research teams of universities, teachers' ethics and teaching performance evaluation should also be highlighted. In terms of evaluation methods, evaluation procedures should be optimized, evaluation methods should be enriched, peer evaluation should be standardized (optimizing the source and structure of experts, and improving the responsibility and credibility system of evaluation experts), and introducing social evaluation and market evaluation; effectively avoid the disadvantages of excessive quantitative evaluation and improve evaluation accuracy; scientifically set the evaluation cycle, focus on process evaluation and result evaluation, and appropriately extend the evaluation cycle of the basic research team.

5. Gather the Power to Continue

In sociology, goal succession is very important to the development of an organization. When an organization faces a situation where the goal has been achieved, the organization cannot deal with the problem with a rigid attitude, but should look for new goals and ensure that Continuity, inertia and stair-stepping of goals. The Chinese nation's leap from standing up, getting rich, to becoming strong is a typical continuation of the goals of the Chinese Communist Party. Poincaré pointed out that every science is a collective undertaking, like an immortal monument. It takes centuries to build it. For this, everyone must carry a stone. In some cases, this stone takes a person's life. energy. Therefore, science requires necessary cooperation, the concerted efforts of us and our contemporaries, and even the joint efforts of our ancestors and our successors. We understand that each person is but a warrior, a small part of the whole. It is this discipline that we all feel together that creates the spirit of the soldier and transforms the vulgar soul of the peasant and the shameless soul of the adventurer into capable of all kinds of heroic acts. [17] The goals of scientific organizations and the continuous efforts of scientists form a mutually reinforcing relationship.

In science, there is a "scientific and technological talent chain principle", also known as the "talent chain growth combination principle", which reflects the relationship between masters and intergenerational cooperation in scientific research. For example, the BCS theory in superconducting research was developed by John Bardeen (1908-1991), an elder who was proficient in solid state physics, Leon North Cooper (1930-), a postdoctoral fellow who was proficient in field theory, and John Schriever, a graduate student. Robert Schrieffer (1931-2019) proposed it, and three people shared the 1972 Nobel Prize in Physics. The 1984 Nobel Prize in Physiology and Medicine was also awarded to three generations of scientists who collaborated with each other, namely 77-year-old Neils K. Jerne (1911-1994) and 57-year-old Cesar Mills (S .Milstein, 1927-2002) and 38-year-old George Celler (1946-1995). More typically, in two generations of Marie Curie's family, four people have won the Nobel Prize five times. Among the students of Joseph John Thomson (1856-1940), the 1906 Nobel Prize winner in Physics, he has won the Nobel Prize seven times. Prize, 12 of the students and assistants of Ernerst Rutherford (1871-1937), winner of the Nobel Prize in Chemistry in 1908, won the Nobel Prize, Niels Bohr (1885), winner of the Nobel Prize in Physics in 1922 -1962), 8 people won the Nobel Prize. In 1938, the Nobel Prize winner in physics Enrico Fermi (1901-1954), 5 people including Yang Zhenning and Li Zhengdao won the Nobel Prize. In 1909, the Nobel Prize Chemistry Prize winner Friedrich Wilhelm Ostwald (1853-1932) has a Nobel Prize-winning mentorship that lasts for five generations. [18] The inheritance and collaboration between generations of scientists is the best form of forming a talent chain, and it is also an inevitable requirement for the continuation of organizational goals and organizational innovation.

In the development of science and technology in the People’s Republic, the aerospace industry and aerospace spirit best embody the virtue of continuous struggle and collaboration. From the establishment of China's own aerospace industry in 1956, to the successful launch of my country's first artificial earth satellite "Dongfanghong-1" on April 24, 1970, the official establishment of China's manned space program on September 21, 1992, and the Formed the first batch of reserve astronaut teams, established the world's third astronaut team in 1997, and then went to "Shenzhou" to fly into the sky, "Beidou" to guide the way, "Tiangong" to range rover, "Mozi" to send messages, "Chang'e" to inquire about the moon, etc. One brilliant achievement after another that has attracted worldwide attention, and through the continuous efforts of several generations of astronauts, China's aerospace science and technology continues to set new records. The continuous struggle of several generations has also given birth to the collaborative spirit of scientists in different periods. In 1956, based on Nie Rongzhen’s proposal, the establishment policy of the Fifth Academy of the Ministry of National Defense was to “give priority to self-reliance, strive for foreign aid and utilize the existing scientific achievements of capitalist countries” "; In 1986, the Ministry of Aerospace Industry proposed the aerospace spirit of "self-reliance, hard work, vigorous collaboration, selfless dedication, rigor and pragmatism, and courage to climb"; in 2005, Hu Jintao summarized the manned space spirit as: love the motherland and win glory for the country The firm belief of the people, the enterprising consciousness of having the courage to climb and dare to surpass, the scientific and realistic, serious work style, and the overall concept of helping each other in the same boat, uniting and cooperating. Entering a new era, we have forged the Beidou spirit of "independent innovation, unity and cooperation, overcoming difficulties, and pursuit of excellence" and the lunar exploration spirit of "chasing dreams, courageous exploration, collaborative attack, and win-win cooperation." In the process of continuous struggle of the aerospace industry, the collaborative virtue of scientists has always been reflected.

On May 7, 2021, China completed its 37th Antarctic scientific expedition. Since Chinese scientists Dong Zhaoqian and Zhang Qingsong joined the Australian Antarctic expedition in 1979, the "Great Wall Station" was established in 1985, Zhongshan Station was established in 1989, Kunlun Station was established in 2009, Taishan Station was established in 2014, and the Ross Sea New Station was laid in 2018. Chinese scientists have carried out research on meteorology, nebulae, earthquakes, ionosphere, upper atmospheric physics, geomagnetism, ice cores, etc., involving glaciology, astronomy, geology, geophysics, atmospheric science and space physics in the Antarctic interior. In other fields, it took the lead to complete the investigation of Grove Mountains, Dome A, and the Ross Sea, discovered the warm ice phenomenon in deep ice canyons, meltwater basins, and wetlands, and realized a three-dimensional scientific expedition coordinated by sea, land, and air, and became one of the Among the advanced countries in Antarctic scientific research in the world, it has formed an Antarctic spirit that is harder than rock. The peaceful development and utilization of nuclear fusion energy is the dream of scientists around the world. In the 1970s, the Chinese Academy of Sciences established the Controlled Thermonuclear Reaction Research Experiment Station and the Institute of Plasma Physics, which became an important base for thermonuclear fusion research; in the 1980s, the Shanghai Institute of Optics and Precision Mechanics of the Chinese Academy of Sciences manufactured Laser No. 12 Device Shenguang 1; in the 1990s, the Institute of Plasma Physics built a superconducting tokamak device; in the new century, China built the Shenguang Advanced Superconducting Tokamak Device EAST, joined the "ITER Project", and achieved many major breakthroughs. The experimental parameters are gradually approaching the physical conditions required for the steady-state operation mode of future nuclear fusion reactors. [19] Over the past 40 years, three generations of Chinese fusion scientists have always adhered to the energy dream of mankind and strived endlessly for it.

6. Conclusion

The article elucidates the critical role of collaborative virtues in modern scientific practice, emphasizing that the respect accorded to science is rooted not merely in its objective foundations but in its exemplary demonstration of human cooperation. Highlighting historical and contemporary examples, the text underscores how the essence of scientific progress has shifted from individual endeavors to organized, collective efforts. The cooperative spirit, essential for both individual scientists and larger research institutions, is portrayed as a vital ethical virtue necessary for the advancement of science. This collaborative ethos transcends individual recognition, promoting team-based accomplishments and the synergistic integration of diverse fields and expertise. The article further advocates for scientific evaluation mechanisms that honor collective contributions, thereby fostering an environment of shared goals and mutual respect. The portrayal of goal succession and intergenerational cooperation as fundamental to sustaining scientific innovation reinforces the idea that science is a collective, enduring enterprise. By nurturing these collaborative virtues, the scientific community ensures the continued progression and enrichment of our scientific endeavors, building a legacy of cooperative excellence.

Compliance with ethical standards

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