The Scientific Brilliance of Zhou Guangzhao Will Shine Forever: Postprint

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Abstract

This article traces the important moments in over 30 years of working together with Mr. Zhou Guangzhao, revisiting his unique personal charisma and his pure and devoted passion for the nation' s scientific and technological endeavors. It ranges from marveling how his spirit has erected a monument for the era to highly affirming his historic contributions to the "Two Bombs, One Satellite" program, national basic research, and the development of the Chinese Academy of Sciences; from rereading his "Seven Key Points of Scientific Spirit" to elaborating on the scientific spirit that both he and I have adhered to throughout our lives. Mr. Zhou and I have always believed that academic democracy and free debate are the only path to flourishing science, that academic tolerance is a materialistic scientific attitude, that the growth of young talent is the future of national development, and that scientific ethics constitute the core connotation of scientific spirit. I also hope that by comprehensively experiencing the scientific radiance of Mr. Guangzhao, I can seek enlightening power for the further development of our nation' s scientific and technological undertakings.

Full Text

Preamble

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Abstract

This article traces the significant moments over more than thirty years of working with Mr. Guangzhao Zhou, revisiting his unique personal charisma and his

profound dedication to China' s scientific endeavors. It reflects on how his spirit established a monumental example for our era, affirming his historic contributions to the "Two Bombs, One Satellite" program, national basic research, and the development of the Chinese Academy of Sciences (CAS). By revisiting Mr. Zhou' s "Seven Elements of Scientific Spirit," the article reaffirms the scientific spirit that both Mr. Zhou and the author have upheld throughout their lives. Both of us have consistently believed that academic democracy and free debate constitute the sole path to scientific prosperity, that academic tolerance represents a materialist scientific attitude, that the growth of young talent determines the nation' s future, and that scientific ethics form the core connotation of scientific spirit. The author hopes that by fully appreciating Mr. Zhou' s scientific brilliance, we can find inspiring force for the further development of China' s science and technology.

Keywords: 973 Plan, scientific thought, scientific spirit, academic democracy, talent

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November 15, 2011, is a day I will never forget. At the Beijing Conference Center, during a meeting of the 973 Plan Expert Advisory Group that I chaired, Mr. Zhou Guangzhao delivered a concluding speech on the mission of the 973 Plan. Moments after he finished speaking, he suffered a cerebral hemorrhage and collapsed beside me. Although he was rushed to the hospital, after three major hemorrhages and two surgeries, he never recovered and could never return to the scientific career he loved and had pursued his entire life. Whenever I recall this moment, I am overwhelmed with mixed emotions that linger for a long time. Mr. Zhou dedicated his entire life to his motherland and to science, making monumental contributions to the vigorous development of China' s scientific enterprise.

In January 2019, following the passing of the respected Mr. Yu Min, only three of the 23 scientists who received the "Two Bombs, One Satellite" Merit Medal in 1999 remain with us: Wang Xiji, Sun Jiadong, and Zhou Guangzhao, with Mr. Zhou being the sole representative from the nuclear weapons field. The older generation of scientists possesses invaluable thoughts and experiences that deserve careful summarization and refinement. I believe the best commemoration is inheritance, and the best consolation is forging ahead. Only by carrying forward their scientific spirit and scientific thought under the leadership of the Party Central Committee with Comrade Xi Jinping at its core can we truly honor their memory and propel China' s scientific enterprise toward greater breakthroughs and achievements.

I have known Mr. Zhou for over thirty years. He has been my guide in career and

my senior leader in work. Over the years, he has provided me with tremendous assistance both professionally and academically. Mr. Zhou has been bedridden for nearly thirteen years now, and each time I visit him, his sincere smile and kind face seem to reappear before me, always giving me encouragement and strength. His spirit of seeking truth, his integrity as a scholar, his rigorous academic style, and his peaceful approach to life have silently inspired me and benefited me immensely. Today, I would like to express my understanding of Mr. Zhou' s scientific spirit and thought, as well as my respect for him, through seven reflections.

1. Mr. Zhou' s Spirit Established a Monumental Example for Our Era

Since 1840, China gradually became a semi-colonial and semi-feudal society, beset by domestic troubles and foreign aggression, with its people living in misery. From the Opium War to the founding of the People' s Republic of China in 1949, China suffered more than 470 foreign invasions, and between 1840 and 1905, was forced to sign as many as 745 unequal treaties. The aspiration to make China a powerful nation that would no longer be bullied by others was the dream pursued by countless patriots and ambitious intellectuals. The May Fourth Movement awakened people to raise the banner of "patriotism, progress, democracy, and science," believing that science is the ladder of social evolution. It was against this historical backdrop that Mr. Zhou spent his childhood and youth, and these years of hardship forged his unwavering patriotic spirit, his broad-minded concern for the world, and his resilient character.

When the People' s Republic of China was founded in 1949, the nation had only slightly more than 30 scientific research institutions and no more than 50,000 scientific and technical personnel. Modern science and technology in China essentially started from a blank slate. In the spring of 1957, responding to the Party' s call, Mr. Zhou embarked on a mission to "march toward science" and went to the Joint Institute for Nuclear Research in Dubna, USSR, to engage in particle physics research. He cherished this precious opportunity provided by his country, studying diligently and winning the institute' s research award twice in four years while publishing 33 papers that attracted acclaim from both the United States and the Soviet Union, the world' s two major power blocs at the time.

In June 1959, the Soviet Union unilaterally tore up its agreement and refused to assist China in developing atomic bombs. By July 1960, all Soviet experts in China had been withdrawn, taking with them blueprints and materials. Upon learning this news, Mr. Zhou was indignant and strongly demanded to return to China to work on atomic bomb research. In his letter of determination to the then Minister of the Second Ministry of Machine Building, he wrote: "As a scientist trained by New China, I am willing to abandon the basic theoretical research I have conducted for many years and switch to work urgently needed by our nation. We stand ready to answer the call of our motherland at any

time!" Driven by this firm conviction, Mr. Zhou returned to China in 1961 as one of the pioneers of China' s nuclear weapons program. He worked at the China Academy of Engineering Physics for 19 years, dedicating the best years of his life to the nation' s nuclear weapons cause and making historic contributions to the successful development of China' s first atomic bomb and hydrogen bomb. Subsequently, he made indelible contributions to promoting the 863 and 973 Plans, establishing the Chinese Academy of Engineering, advancing the institutionalization of CAS academic divisions, establishing the National Natural Science Foundation, building the Beijing Electron-Positron Collider, establishing the China Center for Advanced Science and Technology, and launching the "Huang-Huai-Hai Campaign" for agricultural science and technology.

Great eras produce great figures. For decades, regardless of his position or work, Mr. Zhou always put his motherland and people first. With his devoted heart, he exerted himself to the utmost for the development of China' s scientific enterprise, repaying his country' s cultivation and his people' s nurturing. This year marks Mr. Zhou' s 95th birthday, coinciding with the 105th anniversary of the May Fourth Movement and the 75th anniversary of the founding of the People' s Republic of China. Through his spirit and dedication, Mr. Zhou has proven himself worthy of being a role model of his era, a master of science, and a great figure in history.

2. The "Seven Elements of Scientific Spirit" Represents Profound Philosophy

Through nearly 75 years of unremitting exploration and reflection on scientific endeavors, Mr. Zhou developed a profound understanding of the connotation of scientific spirit. In the 1990s, he proposed that scientific spirit is thoroughly materialist spirit, which he summarized into seven elements (hereinafter referred to as the "Seven Elements of Scientific Spirit"):

(1) Objectivity and truth-seeking constitute the primary requirement of scientific spirit.

(2) The world develops endlessly and changes infinitely, thus the task of cognition is never-ending, and continuous pursuit of knowledge is required by scientific spirit.

(3) Do not follow trends blindly, do not worship authority, do not mistake contingency for necessity, and do not mistake the part for the whole. Do not easily believe in so-called "new discoveries" that have not been repeatedly proven through rigorous experimentation and strict scientific reasoning under meticulous methods. Scientific skepticism is a component of scientific spirit.

(4) Concrete truths are all relative truths that can be broken through, and innovative spirit is an important component of scientific spirit.

(5) Newly discovered truths must contain the content of original truths. Innovation should be conducted on the basis of inheritance, and inheriting all objective laws and correct theories proven by scientific methods is a necessary component of scientific innovation spirit.

(6) Science is organized group activity of society. Therefore, team spirit, democratic style, and letting a hundred schools of thought contend are all components of scientific spirit.

(7) Science should not only understand objective laws of the world but also participate in social transformation and promote social progress. Developing from rational understanding to transformative practice is also a requirement of scientific spirit.

The "Seven Elements of Scientific Spirit" runs through Mr. Zhou' s entire life. Through years of scientific practice and intellectual refinement, it has become precious spiritual wealth guiding the development of science in China. "Truth-seeking" and "fact-based"—that is, "pursuing truth and seeking truth from facts"—represent the two most fundamental aspects of scientific spirit in Mr. Zhou' s view. From his use of "maximum work" calculations with colleagues to confirm data errors in Soviet materials, which ended months of academic debate, to his abandonment of the "light-emitting" path in exploring hydrogen bomb principles, all demonstrate his scholarly integrity of not blindly worshipping books, authority, or foreign sources, but only facts.

During his tenure at the Chinese Academy of Sciences, Mr. Zhou, as a strategic scientist with systematic thinking, emphasized positioning and planning CAS from the perspective of national priorities. He believed that considering CAS development in isolation from national priorities and economic and social development needs would be contrary to social development and hopeless. He summarized this as a universal law for the existence and development of CAS. On this basis, he proposed the "dual-drive theory" for science and technology development: driven by scientists' free exploration, with the main goal of studying basic laws of various substances and their movements in nature and understanding interactions between nature and human society; and driven primarily by national will and social demand, with the main goal of developing the economy and promoting scientific and technological progress through market demand and feedback.

Mr. Zhou consistently insisted on reforming CAS according to the times and China' s actual conditions. In the 1980s, he proposed the institute management policy of "openness, mobility, competition, and collaboration" and the academy management policy of "one academy, two systems," explicitly stating that "different operational mechanisms, management models, and management systems should be adopted according to different characteristics and development laws." At the 1996 CAS Academician Conference, he further emphasized: "The re-

form and development of CAS should break the closed state formed during the planned economy period and rebuild a national academy for all scientists and all people that faces and is rooted in the whole society. We must prove the value of CAS existence through its development achievements."Mr. Zhou's truth-seeking and pragmatic strategic thinking pointed out a scientific direction for CAS' s subsequent development.

3. Promoting Basic Research Is a Historical Responsibility of China' s Scientific Community

In the mid-to-late 1990s, as China' s economy and society developed rapidly, problems related to energy, resources, and ecological environment became increasingly prominent. At the 75th Xiangshan Science Conference, Mr. Zhou sharply pointed out: "Can China' s existing resources and conditions support its development goals? China's population accounts for about 22% of the world' s total; its arable land accounts for 7%; its energy accounts for 10%, and coal constitutes the main body. Following this model, when per capita GDP reaches 7,000 US dollars, China' s energy resources will be unsustainable."

Resource scarcity, increasingly fierce international competition, insufficient independent innovation capability (especially in original innovation), and an industrial development model based solely on imported technology and follow-up imitation became prominent constraints on China' s strategic economic restructuring and overall national competitiveness enhancement. Facing these major issues in China' s development, there were no models to follow and no external forces to rely on. Based on his profound observation of scientific development laws and world scientific frontiers, and always maintaining the perspective of a strategic scientist, Mr. Zhou conducted in-depth research and reflection. From the standpoint of national long-term interests, he put forward a series of strategic thoughts and effective strategic measures on basic research.

He believed that "for China to achieve modernization, it must adopt new development thinking and give full play to the important role of technological innovation and knowledge economy." He emphasized the need to fully mobilize scientists' initiative and creativity, strengthen original innovation capabilities, and provide support for economic and social development. Additionally, Mr. Zhou proposed the "dual-drive" strategic thought for basic research: it should both rely on scientists' curiosity in exploring natural phenomena and laws and depend on their high sense of responsibility and historical mission toward the nation and people. This unique insight provided a solid theoretical foundation for achieving unity between national strategy and scientific exploration.

The 973 Plan, as a banner of China' s basic research work, absorbed much of Mr. Zhou' s painstaking efforts. During his 13 years as head of the advisory group, he put forward a series of forward-looking ideas and developed profound, systematic thinking on the strategic positioning of the plan, scientific evaluation, integration of innovation chains, talent cultivation, resource allocation, and aca-

demic atmosphere construction, forming a thought system for basic research development with Chinese characteristics. The 973 Plan was one of Mr. Zhou' s most focused efforts in his later years. Without him, there would have been no brilliant achievements of the 973 Plan. His final mental and physical energy was devoted to the 973 Plan.

At that advisory group meeting on November 15, 2011, he recalled the past, systematically summarized the successful experiences of the 973 Plan, and envisioned its future. When speaking about the setbacks and hardships CAS encountered in those years, sitting beside him, I sensed the flicker in his eyes and the emotion in his voice, and I understood his difficulties. I sometimes feel deeply remorseful, wondering if he might not have collapsed from exhaustion had I not invited him to deliver that report. Therefore, when I succeeded him as head of the advisory group, I felt that I was taking on not just an important job but also a heavy responsibility entrusted with Mr. Zhou' s earnest expectations, which I dared not neglect for a moment.

4. Academic Democracy and Free Debate Are the Only Path to Scientific Prosperity

The pursuit of academic democracy and free debate has been a consistent spiritual pursuit of Mr. Zhou. In the 1970s, during the exploration of hydrogen bomb principles without any reference materials, Mr. Zhou, together with Deng Jiaxian, Yu Min, and other distinguished scientists, held "speak-out meetings"to encourage young people to speak truthfully and honestly. They specifically conducted education on the "three honesties and four strictnesses" academic style, vigorously emphasized equality before truth, advocated collective 攻关, promoted democracy, pooled wisdom, and encouraged suggestions. It was within such an atmosphere of free and democratic academic discussion that breakthrough progress was achieved in hydrogen bomb principles. From the first atomic bomb to the first hydrogen bomb, the United States took 7 years and 4 months, the Soviet Union took 4 years, France took 8 years and 6 months, while China took only 2 years and 8 months.

Recalling those glorious years in 2005, Mr. Zhou specifically stated: "Academic democracy and free discussion are the most precious spiritual wealth; without the pursuit of scientific democracy, our atomic and hydrogen bombs would not have been achieved so rapidly."He also noted that "different opinions and debates are an important driving force for scientific development." Debates over different viewpoints reflect both scientific perspectives and academic ideas, and embody academic thought and scientific spirit, constituting an extremely important part of science and playing a very significant role in its development. He pointed out: "Academic criticism should be a perfectly normal practice, but in China it doesn' t work, especially criticizing authorities, which has almost become a vacuum. Once an authority or leader speaks, others are not allowed to speak, and no one dares to speak."

Mr. Zhou consistently practiced academic freedom and let a hundred schools of thought contend through his own example. Simultaneously, he always insisted that administration should not interfere with academia, emphasizing that administration should provide good service, create better conditions for academic development, and remove obstacles for academic research. Speaking truth and telling facts left the deepest impression on me. He mentioned to me many times that if science loses academic freedom and democracy and becomes bound by hierarchy and seniority, the future development of Chinese science would be worrisome.

5. Academic Tolerance Is a Materialist Scientific Attitude

Mr. Zhou once said: "A promising scientist must not only value theory but also value experiments. Consistency between theory and experimental results is certainly gratifying, but a promising scientist must particularly grasp instances where theory and experiments disagree, because such instances reveal deficiencies in theory or experiments and may lead to new breakthroughs." This statement reflects his profound understanding. He sharply criticized the blind pursuit of publication numbers in China' s scientific community: "We must avoid a utilitarian evaluation system and promote the spirit of spending ten years sharpening one sword, guiding scientists to engage in work with more long-term impact and greater scientific significance." He proposed that original innovation capability should be an important evaluation indicator, enabling the most creative ideas to receive strong support. He also emphasized that interdisciplinary research should be promoted, as breakthrough discoveries and innovations are most likely to emerge from interdisciplinary fields.

The journey toward major discoveries involves setbacks and failures. Scientists entering new fields must be confident, unafraid of failure or ridicule, and strive with unwavering determination to achieve their goals. Success should be encouraged, but failure even more so. There are no failures on the path of scientific exploration, only pioneers, and everyone who moves forward is a hero. For a long time, a "copycat" mentality has persisted in China, with research work characterized by a keenness to follow and imitate. Mr. Zhou pointed out incisively: "A mentality lacking confidence yet seeking quick success is one of the major obstacles constraining creativity. Being good at learning and having high confidence are important qualities of talented individuals." High-end technology cannot be learned or bought, and China has had too many painful lessons of this kind. We must treat scientific research with an inclusive heart, allowing mistakes and encouraging trial and error. Simultaneously, we must listen humbly to different academic viewpoints and accept criticism from others. Only in this way can our scientific enterprise achieve more vigorous development.

6. The Growth of Young Talent Is the Future of National Development

Mr. Zhou attached great importance to talent, particularly the cultivation of young people, and encouraged any progress made by youth. He emphasized on many occasions that innovation should be people-oriented and that young people are the hope of the nation and its cause. He stressed: "We must vigorously cultivate high-level young scientific and technological talent. To build an innovative country, we must bring up a large number of talents of all kinds who master modern scientific and technological knowledge and humanistic knowledge and are full of creativity, forming an innovative team with strategic guidance, vision incentives, cohesion, and creativity."

For the growth of young people, Mr. Zhou personally taught them starting from the 1960s. At the beginning of China' s nuclear weapons development, Chinese researchers were unfamiliar with basic theories such as detonation theory and shock wave theory. With the acumen of a theoretical physicist, Mr. Zhou systematically taught young people professional knowledge of nuclear weapons physics, even though he himself had conducted basic research in particle physics and other fields while in the Soviet Union. Mr. Zhou used his profound knowledge and diligent spirit to first study the material thoroughly himself before teaching it to young people. His dedication and practical actions set an example for the younger generation.

Mr. Zhou not only made every effort to consciously cultivate talent and help them grow professionally but also dared to stand up and protect them at critical moments. Around 1970, under the political pressure of "engaging in production as a sideline" during the Cultural Revolution, Mr. Zhou risked being accused of "impacting politics" by fighting against political activities encroaching on research time, even ordering the cancellation of political activities arranged by political work departments. Some comrades recalled how Mr. Zhou worked to clear their name when they were suspected of being major criminal suspects in the "Three Major Counter-Revolutionary Cases."During the 1989 turmoil, when some in society began to distrust the scientific and technological workforce and some scientific and technical personnel felt psychologically bruised, Mr. Zhou bravely stepped forward to encourage everyone: "I believe our vast number of scientific and technical personnel are trustworthy!" These words were shocking and inspiring, giving great encouragement to the broad scientific and technical community. At that time, without broad selfless mind and political courage to take responsibility, one would not have dared to stand up.

7. Scientific Ethics Are the Core Connotation of Scientific Spirit

During his tenure as CAS President, Mr. Zhou proposed that academicians should become active promoters of scientific ethics construction and role models for national scientific and technical workers. At the 1994 CAS Academic Divi-

sions Joint Office Work Conference, he emphasized that academicians should become examples of adhering to rigorous, serious, and strict scientific attitudes and seeking truth from facts. At the 1996 Academician Conference, Mr. Zhou solemnly stated: "Fraud and hypocrisy in society have already affected the scientific community. In recent years, in project approval, achievement evaluation, and professional title assessment, phenomena of being unrigorous, unserious, and even ignoring scientific norms, disregarding scientific ethics, exaggerating, and falsifying information have occurred from time to time." Mr. Zhou' s serious criticism remains deafening and thought-provoking to this day.

The CAS Academic Divisions and academicians represent the highest academic institution and the highest academic title in China' s scientific community, possessing supreme authority and honor. We must inherit the fine traditions of senior scientists, uphold truth, seek truth from facts, conduct rigorous scholarship, be meticulous, strictly discipline ourselves, and selflessly dedicate ourselves. With truly profound knowledge and noble moral character, we should serve as paragons for society and promote its healthy development.

Human civilization has continued for 6,000 years, and humanity' s progress has benefited from continuous cognition of nature and obtaining resources for survival from it. How can we promote sustainable human development for another 6,000 years? What can we contribute to the future? This is a profound topic that requires our collective answer. However, I believe that studying and learning from Mr. Zhou' s spirit and character can provide us with highly beneficial enlightenment.

Salute to Mr. Zhou Guangzhao! May his scientific spirit live forever!

Acknowledgments

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Note: Internal documentation references marked with and in the original text correspond to:

Zhou Guangzhao' s speech at the CAS Work Conference, January 1988.

Zhou Guangzhao's academic report at the Institute of Nuclear Weapons Theory, 2005.

Note: Figure translations are in progress. See original paper for figures.