



Interview

“My life can be said to form a circle”

— An interview with Nobel laureate Professor Chen-Ning Yang

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Editor’s note: Chen-Ning Yang (杨振宁, 1 October 1922 –), or C.N. Yang or by the English name Frank Yang received the 1957 Nobel Prize in Physics with Tsung-Dao Lee for their work on parity non-conservation of weak interaction. Yang and Robert Mills also proposed the non-abelian gauge theory, widely known as the Yang–Mills theory. Yang and Baxter found the Yang–Baxter equation that plays an important role in integrable models and has influenced several branches of physics and mathematics. Professor C.N. Yang is not only a great physicist, but also an outstanding educator and a thoughtful philosopher. This edited interview was conducted in 2014 by the author. Parts of the Chinese version were published in a few Chinese newspapers and magazines at the time. This English version, translated by Tyler Ross from New York, USA, provides readers worldwide with an opportunity to share and understand Professor Yang’s long-lasting successful journey and thoughts on scientific preparation and innovation, cross-disciplinary integration, and effective collaboration, in particular how Yang’s in-depth understanding and appreciation of mathematics in his successes in physics. This interview is also to celebrate Professor Yang’s 101st birthday and his public speech at Zhejiang University in China in 2014.



Keywords: Chen-Ning Yang, interview, Nobel laureates, scientific preparation, cross-disciplinary integration, effective collaboration

Introduction

Yang Chen-Ning spent his childhood at Tsinghua Campus in Beijing, and it was to Tsinghua Campus that he returned in 2003 when he came back to China, taking up residence in a small courtyard house in Zhaolan Yard. He named this little home *A Return to Roots*, and wrote a poem with the same title.

Mr. Yang and his wife, Weng Fan, spend most of their time in Tsinghua Campus, sometimes visiting the Chinese University of Hong Kong on holidays. In addition to attending necessary public events, he and Weng Fan have many mutual friends in their daily lives, and from time to time they attend private gatherings. I remember that Weng Fan once revealed to me that Mr. Yang likes to sleep late in the morning. A year ago, Mr. Yang was fitted with crutches, just in order to make walking a bit faster, safer, and more convenient.

I have been corresponding with Mr. Yang for nearly three years, starting when I invited him as a guest speaker to the Lecture Hall of Science at Zhejiang University, at which I serve as forum leader. After having been introduced through a friend, we corresponded by email; I wrote in Chinese and he replied in English, usually within an hour or two. Mr. Yang had originally promised to come to Hangzhou in the spring of 2013, and everything was arranged, but the morning before he left, Mr. Yang called me to cancel the trip because CCTV News had reported the presence of bird flu in Shanghai. This was during recess and his voice was so loud that the students could hear him. A few minutes later, he called again and said that there were no occurrences in Hangzhou yet, so that he could still come. But later that same day, it was reported that there had been a bird flu death in Hangzhou, and Mr. Yang wrote to me that night to confirm the cancellation of the trip. A few weeks later, I sent Mr. Yang my questions for this interview, and after two days I received his answers, which he had written in the margins himself with a fountain pen.

In March of this year (March 2014), Mr. Yang informed me that he was coming to Hangzhou, and I finally had the opportunity to welcome him here. It was a privilege to spend a few hours alone with him at Liuzhuang West Lake State Guesthouse, and we continued our conversation during the trip to and from Zhejiang University and to the airport, and even waiting in the VIP lounge. When I finished writing it up, I sent it Mr. Yang for several corrections.

From this trip to Hangzhou, we can see that although he is ninety-three years old, Mr. Yang still has a quick mind and a good memory; only the response of his right ear is slightly slow since he began wearing a hearing aid. During his speech at Zhejiang University, a reporter noticed that he didn't take a sip of water for two hours. Mr. Yang is good at communicating with people and was happy to respond to requests from his admirers for group photos; during our time together this included the waitstaff at Liuzhuang and in the VIP lounge at Hangzhou Xiaoshan Airport. Pictures 1 & 2 were taken during Professor Yang's visit to Zhejiang University in 2014.



Picture 1. The audience and atmosphere in Professor Yang's public speech (by author).



Picture 2. Ninety-two years young Professor Yang in his 2014 visit to Zhejiang University (by author).

The interview

1. *Cai: Hello, Mr. Yang! First of all, thank you very much for accepting our invitation to be our guest at the Science Lecture Hall of Zhejiang University, and also for agreeing to this interview. Unfortunately, President Yang Wei, who wrote a letter to you himself, has left Zhejiang University and cannot be here to welcome you in person. When he learned that you were coming to Zhejiang University, he wrote back to me and said, "I am very glad that Mr. Yang is finally able to come!" I would like to know how many times you have been to Hangzhou before, and do you remember when you first saw West Lake?*

Yang: I came to Hangzhou for the first time in the summer of 1972, and I have been here five or six times. Almost every time I came to Zhejiang University; the first time was during the Cultural Revolution; I visited Yuquan campus for a stroll, but did not encounter a single acquaintance. President Yang Wei is also a Tsinghua alumnus, but we haven't met since he left Hangzhou to work in Beijing. (Note: The day before Mr. Yang's visit to Zhejiang University, he had already met with the newly appointed President Lin Jianhua. On the day of the lecture, the future President Wu Chaohui personally accompanied him. When chatting with me, Mr. Yang mentioned the late professors Prof. Wang Rong and Prof. Li Wenzhu of the Physics Department of Zhejiang University, and asked if Mr. Tsung-Dao Lee had recently returned to pay any visits to his alma mater).

2. *Cai: You were born in Hefei, the same town as Li Hongzhang (exactly one century apart). At that time, Hefei was just a county in Anhui, and your father was a high school teacher in Anqing, the provincial capital, which was then called Huaining; this is where your name Chen-Ning comes from. Also, your childhood friend Deng Jiaxian was born in Huaining; he was your classmate through high school and college, and later a roommate in New Jersey when you were studying in the United States. Are you familiar with the poet Hai Zi, born in 1964 in a village in Huaining County, who committed suicide at the age of 25 in Shanhaiguan and is now practically a household name in China? Have you read any of his poems?*

Yang: I haven't heard of Hai Zi, nor have I read any of his poems. I was born on a small street called Si Gu Xiang in Hefei, where I lived until I was six years old. Some years ago I went back to Hefei and visited the "Former Residence of Yang Zhen-Ning", but it was not the same place where I spent time as a child. Of course, I didn't say that to the receptionist. Si Gu Xiang was named after four ancient tombs that once stood there¹, and it is said that the name of this alley was recorded in the *Hefei County Annals* more than two hundred years ago.

3. *Cai: Your father left to study in the United States when you were less than a year old. You saw him again at the Port of Shanghai when you were six years old, and your family went to Xiamen together, where you saw electric lights, ate bananas and drank milk for the first time. A year later your father was hired by Tsinghua University, and you came to Beijing and lived at Tsinghua Campus for eight years. It is said that you excelled in mathematics as a child and could already read Hardy's *An Introduction to the Theory of Numbers* and *E. T. Bell's Men of Mathematics*. However, your father,*

¹ Si Gu Xiang means Four Ancients Alley in Chinese (Translator's note).

himself a mathematics professor, hired a teacher of ancient languages to teach you Mencius. How did this experience shape your later life?

Yang: My father taught at Xiamen University for one year after he returned to China, and in the summer of 1929, he accepted an offer from Tsinghua University, and our family went from Xiamen to Beijing via Shanghai. We lived at Tsinghua Campus in Beijing, which was called Beiping at that time. My eight years at Tsinghua Campus were beautiful, and everything is very nostalgic for me. At that time, Tsinghua University was small, but there were about fifty children of faculty members, so an elementary school was established and I studied there. The stories in Mencius had a great influence on me, showing me the worldview of traditional Chinese culture and the principles of being human.

4. *Cai: My father was one year older than you and, like you, attended National Southwestern Associated University in Kunming in the 1940s. He studied history, and, also like you, he attended Mr. Wen Yiduo's poetry class; but he passed away thirty-four years ago. I would like to ask you how many students were enrolled at Southwest Associated University each year, and how many professors and teachers were there? How was the life of the students? Was there any exchange between Southwest Associated University and Zhejiang University, which was also located in Guizhou in Southwest China during the war? What is your fondest memory there?*

Yang: At that time, the university enrolled about four hundred new students each year, and I don't remember any exchanges with Zhejiang University. The undergraduates of National Southwestern Associated University belonged to three universities that had been merged into one, with graduate students managed separately by each school, although at that time it seemed that only Tsinghua had a graduate school, on account of the Boxer Rebellion Indemnities. As for my personal hobbies, I liked to sing when I was young, although I didn't sing very well. After the Marco Polo Bridge Incident, our family first returned to Hefei, and I continued my studies. The following year, I had not yet graduated from high school, and was admitted to the Southwest Associated University with the same academic qualifications.

5. *Cai: Your father, Mr. Yang Wuzhi, was the first Chinese Ph.D. in number theory (at the University of Chicago), a senior colleague whom I admired. He proved that every positive integer admits a representation as a sum of certain cubic polynomials, which Mr. Wang Yuan later praised as a very good result for those days. In fact, this was a variation of Waring's problem, and he proved that each positive integer can be represented as a sum of at most nine tetrahedral numbers. Eighty-six years have passed, and this has been improved only to eight tetrahedral numbers. In 1994, you published a paper in Science in China—Mathematics (with Yuefan Deng) that argued heuristically and with numerical data that every positive integer should admit a presentation as a sum of at most five tetrahedral numbers and sufficiently large positive integers as a sum of at most four tetrahedral numbers. Was this a tribute in memory of your father?*

Yang: I cannot say this was a tribute to my father. I tried to read his doctoral dissertation, but found that I couldn't understand it quickly because there were so many lemmas. I figured it would take at least a week or two to understand it, so I gave up. (*Note: Coincidentally, the day Mr. Yang gave a*

lecture at the Zhejiang University was April 14, 2014, which also happened to be the 118th anniversary of the birth of Mr. Yang Wuzhi.)

6. *Cai: When your father was teaching at Tsinghua University, he sparked Hua Luogeng's interest in number theory, and after Hua returned from a visit to England, your father advocated for his extraordinary promotion to full professor with only a secondary school education. Were Hua Luogeng, Shiing-Shen Chern and Pao-Lu Hsu already famous when you entered National Southwestern Associated University? I heard that your first girlfriend was a senior student of mathematics and had been your father's teaching assistant. What I want to know is why you entered the chemistry department instead of the mathematics department. There is a legend that at that time you felt that there was no Nobel Prize in mathematics?*

Yang: When I was a student at National Southwestern Associated University, Hua, Chern, and Xu were already very famous. I had liked Zhang Jingzhao, who was from Shengzhou, Zhejiang and later taught at Peking University. As for the legend, it is completely unfounded. I chose chemistry because my father thought that chemistry might be more useful than mathematics. But I didn't even wait for the start of the school year to petition Wu Youxun, Dean of the Faculty of Science, to switch to the Physics Department, in which I was successful. In those days, all the girls wore blue cloth coats, but Jingzhao Zhang stood out in a red suit. (*Note: Mr. Yang once said that before he met Zhang Jingzhao, his mood was like a calm lake, and after he met her, it turned into a storm; so perhaps this was his unrequited love. In 1968, in the midst of the Cultural Revolution, Zhang Jingzhao committed suicide in a restroom at Peking University.*)

7. *Cai: In 1945, you went to study in the United States on an American troop carrier via India. That was your first trip abroad, right? Do you remember that trip? How long did it take? What ports did you pass through? I remember that when Hua Luogeng set off from Kunming to the Soviet Union in 1946, he also traveled from Calcutta. He chose a combination of land and air routes, passing through Pakistan, Iraq, Iran, Azerbaijan, Georgia and other countries, and it took more than a month.*

Yang: About twenty of the United States Boxer Indemnity students flew to Calcutta from Kunming at the end of August 1945, boarded an American troop carrier in late October, and arrived in New York in late November via the Red Sea, the Mediterranean Sea (and the Atlantic Ocean). We did not take a ship across the Pacific Ocean because, although Japan was defeated at that time, it had not yet officially signed the surrender, and although the sea route was shorter, it was more dangerous.

8. *Cai: Chicago, on the shores of Lake Michigan, was at the center of American culture in the 19th century and into the first half of the 20th century. The magazine Poetry, founded in 1912, is considered the most important venue for avant-garde poetry in the 20th century; Sister Carrie by Theodore Dreiser broke new ground for American literature, and Ernest Hemingway was born outside Chicago. Later, Saul Bellow taught at University of Chicago. The University of Chicago is also world-renowned for its mathematics and physics, and you went to Princeton, the world's highest temple to natural science, after earning your doctorate at the University of Chicago. You have done major work throughout your life in the glow of both these institutions. What are your different*

feelings and memories of these two cities? Did the Institute for Advanced Study contribute more to mathematics than to physics?

Yang: I learned the methods and attitudes of doing research at the University of Chicago, and then my seventeen years at Princeton were the most successful seventeen years of my life in research. But you are right that the Institute for Advanced Study has done more in mathematics than in physics. (Note: Before Mr. Yang came to Hangzhou, he saw an article on von Neumann in my book *Unattainable Heights: The Shining Stars of the Mathematical Sky*, published in Taipei, in which I mentioned that when the Institute for Advanced Study celebrated its sixtieth birthday in the 1990s, it commemorated three landmark achievements: Gödel's research on the continuum hypothesis, von Neumann's research on algebra and the mathematical foundations of quantum mechanics, and the work of Chen-Ning Yang and Tsung-Dao Lee on parity violation. Yang was not yet aware of this and wrote to ask me for the source in order to verify it for himself.)

9. Cai: *You have said that although Newton knew that his Mathematical Principles of Natural Philosophy was an extremely beautiful work, he could not have realized that his work would change mankind's understanding of the basic structure of the physical and biological world, and would change forever the relationship between mankind and the environment. In this sense, how would you rate your work? Examples include non-abelian gauge theory, the theory of parity violation, and the Yang-Baxter equation. Is non-abelian gauge theory dominant in gauge theory? What is the current status of research on gauge theory, which along with Maxwell's electromagnetic field theory and Einstein's gravitational field theory are the three major field theories discovered by humans so far?*

Yang: I was fortunate enough to realize early on that there had to be a mathematical basic theory or principle controlling the propagation of the "force". At the same time, I became interested in symmetry very early on, and the two together gave rise to non-abelian gauge theory. This theory is obviously an important step, but it does not yet fully address the ultimate goal of unified field theory. This ultimate goal was also the goal to which Einstein devoted himself in his later years, when he tried unsuccessfully to establish a unified field theory that would encompass both electromagnetism and general relativity.

10. Cai: *In 2000, the existence and mass gap problem of Yang-Mills theory was one of the seven Millennium Prize Problems proposed by the Clay Mathematics Institute in New York, with your name and that of Mills the only names belonging to non-mathematicians in the list, something to be envied by many a mathematician. Do you think that your mathematical intuition comes from genetics or from other aspects of your education? Someone described the research style of Poincaré as that of a pioneer, not a colonist. What about your own style of research? Do you love whatever task you take to, not abandoning the old but creating something new?*

Yang: I think I appreciate mathematics partly because of genetics and partly because I had the opportunity to be exposed to it very early. As I said before, my initial understanding of group theory came from my father, and the bachelor's and master's theses I completed under Mr. Wu Dayou and Mr. Wang Zhuxi respectively when I was in Kunming were on symmetry principles and statistical mechanics, which later became my main research directions for my entire life. In terms of research

topics, I like to work on new things without blindly seeking novelty. For example, string theory is an emerging field in theoretical physics, and many mathematicians are involved in it, but it seems that string theory is not yet as significant to physics as it is to mathematics.

11. *Cai: You have quoted Einstein as saying, "The true laws cannot be linear, nor can they be derived from linearity." You have also talked about Einstein's preference for geometry, and his suggestion that gravity and mechanics should be described by Riemannian geometry, and that electromagnetism is also geometric. You also pointed out that the geometric structures for which Einstein was looking were gauge fields, and that the simplest abelian gauge field was Maxwell's electromagnetic field, while non-abelian gauge fields are necessarily nonlinear. You were very excited when you discovered in 1975 that gauge fields are closely related to Mr. Chern's fiber bundles, and you should have a personal preference for geometry. However, in recent years, there have been many international academic conferences on physics and number theory. For example, the application of the Möbius inversion formula to a range of problems in condensed matter physics. Are you aware of the progress in this area?*

Yang: This sounds very interesting, and if there are really results in this area, please write to me when you find any relevant articles or materials. In October 2011, I gave a report at the 100th anniversary of Mr. Chern's birth held by Nankai University. Later, I edited the speech into an article *Quantum Numbers, Chern Classes and a Bodhisattva*, and submitted it to *Physics Today* for publication. I remember that I sent you a proof copy of it, and one of the subsections was entitled *When Physics Meets Geometry*. (Note: During his lecture, Mr. Yang mentioned that he had worked with Einstein for many years and often saw him at Princeton, and knew his routine. Once Mr. Yang was waiting by the road when Einstein walked by, and he had his young eldest son stand in front of Einstein to have his picture taken. Later, Mr. Yang remarked that he still regrets that he did not take a picture with Einstein at that time.)

12. *Cai: Nearly 12 years ago, you proposed four words as a tentative comparison between four theoretical physicists of the generation just before yours: Pauli (forceful), Fermi (robust, strong), Heisenberg (profound insight), and Dirac (Cartesian purity). You also mentioned that the relationship between Pauli and Heisenberg was once very tense. If you were to make an attempted comparison between yourself and a few of your peers, what words would you choose (Chen-Ning Yang, Tsung-Dao Lee, Chien-Shiung Wu...)?*

Yang: Sometimes physics and mathematics are different. Take the 19th century, for example: mathematics, viewed from a distance, had more than twenty large and small hills, while physics, viewed from a distance, had only a few large hills.

13. *Cai: You were a speaker at the 1960 Gibbs Lecture of the American Mathematical Society, and at the 2008 Einstein Lecture of the American Mathematical Society, the British-American physicist Freeman Dyson praised you and your gauge theory, and his lecture, Birds and Frogs, was later published in the Notices of the American Mathematical Society (2009); this article has been very influential among mathematicians. I have also read his book about you, A Conservative Revolutionary, in which he states that "Yang's sense of the beauty of mathematics illuminates all his*

work". He considered you the architect par excellence of 20th century physics after Einstein and Dirac. I noticed that some of your masterpieces were done in collaboration with others, which shows that you are good at communicating and collaborating with others. In his later years, Shiing-Shen Chern summarized his three closest Chinese friends and three closest foreign friends. If you were to make a similar summary, what would be your answer?

Yang: I have done research with many people in my life, and the most successful collaborations have been with Tsung-Dao Lee, Mills and Wu Dajun. Although the Yang-Baxter equations are also famous, Baxter and I did not work together, and I was unhappy about his fate. (Note: Baxter worked independently on these equations after Yang. Wu Dajun was a student of Yang, a professor at Harvard University, and a member of Academia Sinica in Taiwan, and the two collaborated extensively in areas such as unified quantum field theory and particle physics.)

14. *Cai: Dyson mentioned that he learned more from talking to Fermi for twenty minutes at a critical point in his academic career than he did from his twenty years of association with Oppenheimer, father of the atomic bomb. After your doctorate, you worked as an assistant to Fermi for a year. On the 100th anniversary of his birth, you also wrote an article in his honor, holding him up as one of the most respected and admired of all the great physicists of the 20th century. I would like to know what you would say about your mentor, Edward Teller, the father of the hydrogen bomb? And his Hungarian hometown friend, von Neumann, who like you, originally studied chemistry and worked across a range of fields like nobody else. Did you have any interaction with him at Princeton? I also noticed that although you have many collaborators, you have not mentored many students. Is it because you expected too much of your students?*

Yang: Regarding Teller, he was very smart and extremely innovative. He was good to his friends, and I personally never saw him treating people badly. I was very involved in research when I arrived at Princeton, and by the time I had achieved my results, von Neumann was very ill, having been exposed to nuclear radiation as a result of his involvement in the atomic bomb tests. I did not have many Ph.D. students because I was reluctant to accept new graduate students when I don't have good topics for them. (Note: Mr. Yang carried out an analysis of the differences in character between Deng Jiaxian and Oppenheimer, saying that the former was very reserved and the latter was sharp, and that both China and the United States found the most suitable person to lead the design of the atomic bomb.)

15. *Cai: Not long ago, the Chinese government proposed that universities should lead culture, a fourth task in addition to the cultivation of human ability, scientific research and serving the economy. In your opinion, what can and should university teachers, including those in the natural sciences, do? After the 1952 reorganization of Chinese higher education and the subsequent division of arts and sciences, this task has become significantly more difficult. Is this related to the exclusive reliance on Confucianism for more than two millennia? After the Duke of Zhou and Mozi, there was no one else who straddled the arts and sciences, and Confucius never seemed to mention mathematics or physics in his doctrine.*

Yang: Every kind of work in introductory scientific research and popularization deserves attention

and value around the world. I have one idea: right now Chinese college students are struggling with employment, if ordinary undergraduate colleges and universities, secondary schools and other institutions had people dedicated full time to the popularization of science and teaching of scientific culture, then not only would it contribute to improving the scientific literacy of everyone, but we can also solve a large number of problems of unemployment among the educated youth.

16. *Cai: After reading your book Dawn Collection (SDX Joint Publishing Company, 2008), I realized that you are also a great writer of popular science, reminding me of Euler in the 18th century. In the article Beauty and Physics you describe three domains of physics as experimental, phenomenological, theoretical and their relationship with mathematics, pointing out that the latter is the highest state of physics, with examples given by Tycho Brahe, Kepler, Newton respectively. You also mentioned that mathematics is the language of theoretical physics, and compared the relationship between mathematics and physics to two leaves that overlap at the stem. In 2009, more than a dozen of us mathematicians from different universities at home and abroad founded the quarterly journal Mathematical Culture to explore the culture, ideas and methods of mathematics and to create a bridge between mathematics and the natural sciences, humanities, engineering and everyday life. Have you been able to receive regular copies of our journal?*

Yang: I read a few issues and thought it was very good. (Note: During our casual conversation, Mr. Yang talked about the article introducing the number theorist. Min Sihe, serialized in the latest issue of Mathematical Culture. He remembered its details and added that he admired Mr. Min, and in fact it turned out that the Yang and Min families were closer during the National Southwestern Associated University period. This article was co-authored by editorial board member Dr. Zhang Yingbo and one of the editors-in-chief, Dr. Liu Jianya, and Mr. Yang also mentioned his first meeting with another editor-in-chief of Mathematical Culture, Dr. Tang Tao, in Australia.)

17. *Cai: In 1986, you talked about the contributions of the German mathematician Hermann Weyl to physics, about two things he cherished in his life – gauge field theory and non-abelian Lie groups, which later you and Mills synthesized to develop non-abelian gauge field theory. You also refer to Weyl's book Philosophy of Mathematics and Natural Science (1926) and to the lines by T.S. Eliot that are quoted in the book, "Home is where one starts from. As we grow older / The world becomes stranger, the pattern more complicated / Of dead and living." This is a verse from East Coker (1943), one of the Four Quartets; do you know who translated it into Chinese?*

Yang: I don't know about that. When we were in Haining, Weng Fan and her sister had visited Xu Zhimo's former residence². (Note: During this visit to Hangzhou, Mr. Yang was invited to Haining, Jiaxing to attend the commemoration of the 100th anniversary of the birth of Zha Jimin, a famous Hong Kong industrialist and philanthropist. During our chat, Mr. Yang also talked about his dialogue with Mo Yan, contact with the poet Bei Dao, and assistance for his return to China to visit relatives and work in Hong Kong. He also asked me how I knew Mo Yan and I mentioned Ha Jin and his novel Waiting, about which both he and Weng Fan remarked that it was difficult to read.)

² Xu Zhimo was a Chinese romantic poet of the early 20th century (Translator's Note).

18. *Cai: Qin Jiushao was a mathematician of the Song Dynasty and the most accomplished and internationally renowned ancient Chinese mathematician; the Chinese Remainder Theorem, which he discovered, appears in every course in basic number theory in China and abroad, and has important applications in abstract algebra and a number of other current areas of science and mathematics, such as cryptography. Last year, a bridge named after him, the Dao Gu Bridge, was renamed and erected on the banks of the Xixi River in Hangzhou. George Sarton, the Belgian-American historian of science and founder of the modern discipline of history of science, wrote that "[Qin Jiushao was] one of the greatest mathematicians of his race, of his time, and indeed of all times." In your opinion, who was the best physicist in ancient China? And what was the best work?*

Yang (*after thinking for a while*): Shen Kuo, who was from Hangzhou and wrote *Mengxi Bitan* (*Dream Pool Essays*), which talked about the discovery of optics. Do you know it? During the Qianlong period of the Qing Dynasty, foreign missionaries brought with them glass, which emptied the streets of Beijing as everyone went to have a look, since at that time, the Chinese did not yet know how to make glass and women used bronze mirrors to look at their reflections. (*Note: I had planned to suggest on my way to see him off that Mr. Yang should stop at the Dao Gu Bridge, named after Qin Jiushao, and in this way have the two most accomplished scientists in Chinese history meet for a photo. Unfortunately, that day happened to be the first day the Hangzhou Airport Expressway was closed for road construction, so we were forced to take a detour.*)

19. *Cai: Physics today faces a strong competitor, the "upstart" biology. Would you agree with this? The double helix structure of DNA discovered by Watson and Crick stands with Newton's law of universal gravitation in physics. In this comparison, Darwin's theory of biological evolution is equal to the law of free falling objects in physics, discovered by Galileo, although he failed to explain its precise cause. Has the Einstein of biologists not yet appeared?*

Yang: You've heard the story of Rosalind Franklin, I guess, and if not I'll tell you about it. She was a British chemist and crystallographer, and in fact it was Miss Franklin who first took the double helix crystal diffraction pictures (somewhat blurred) that became the key factor in finally working out the structure of DNA. And yet, Franklin received no honors during her lifetime. She died of ovarian cancer in 1958 at the age of thirty-seven, and four years later, Watson, Crick and Wilkins received the Nobel Prize in Physiology or Medicine for their work on DNA. Wilkins was a colleague of Franklin's at King's College, London. Watson and Crick came to Miss Franklin to collaborate, but she turned them down. She thought herself capable of obtaining clear pictures, which Wilkins had seen and described to Watson and Crick without her permission, enabling them to find the double helix structural model for DNA.

20. *Cai: As I understand it, you also have a special respect for another, male, Franklin, an American who was both a scientist and a politician, and you named both yourself and your eldest son Franklin in English, although you never got involved in politics. Not long ago, Li Yuanchao, a mathematics graduate of Fudan, was elected vice president of the country. You met with Deng Xiaoping before,*

and his wife Zhuo Lin graduated from the physics department of Peking University (Liu Shaoqi's³ wife Wang Guangmei also studied physics at Fu Jen Catholic University, where she stayed on to teach after completing her master's degree. She was a classmate of your first wife, Du Zhili), and a couple of their children also studied physics, so it seems that the Deng family physicists are more influential than the politicians (laughs). What do you make of all this?

(Note: Mr. Yang did not answer this question, but talked to me instead about the time when Mao Zedong met with him in his study in Zhongnanhai in 1973, mentioning one detail in particular. At that meeting, Mao talked to him mainly about philosophy. When the discussion came to Guan Zhong, a politician and military man during the Warring States period, he was particularly excited and suddenly sped up his speech, and Mr. Yang could not understand his Hunan accent for a while. At this time, Zhou Enlai, who was sitting on the side, took the initiative to switch places with Zhou Peiyuan, a physicist beside Mao Zedong, and temporarily acted as an interpreter for Mr. Yang. Coincidentally, Liuzhuang, where Mr. Yang stayed during his trip to Hangzhou, was also the residence of Mao Zedong during his many visits to Hangzhou in his later years. Mr. Yang once pointed to the octagonal building next to his bedroom and told me that the teams of Zhou Enlai and Nixon negotiated and drafted the Shanghai Communiqué there.)

21. Cai: In the summer of 1971, when you returned to China for the first time after a gap of twenty-six years, why did you choose to enter from Myanmar? I remember that Dr. Kissinger's visit to China later that year was by way of Pakistan. You met your parents in Shanghai and visited places like Beijing and Dazhai in Shanxi. That trip must have been very emotional for you. Did you have a vision of the China of today at that time?

Yang: At that time, only Air France had flights to China and they had to go through Yangon, then the capital of Myanmar, so I had no other choice, I went to Europe. Yes, China has changed so much, I could never have imagined how much China would change in the next forty years. That air trip was memorable, and I remember that the first thing I saw from the air after crossing the border was Kunming, the city where I had attended college and lived before I left China. However, starting from 1957, my father was able to reunite with me in Geneva.

22. Cai: There is a saying in Chinese folklore, the "seventh year itch"⁴. You and Weng Fan have been married for ten years now. How do you feel about married life? I heard that you like to use a DV recorder, so you must like to travel. How many countries have you traveled to in your life? How many cities have you lived in for more than a year? What places have you and Weng Fan traveled together since your marriage?

Yang: We have been to many countries over the years, but we only live in Beijing and Hong Kong. We have been to the United States many times, but only for a month or two at a time. (Note: On a

³ A revolutionary and politician who held extremely high positions for fifteen years under Chairman Mao prior to eventually falling out of favor (Translator's Note).

⁴ Indicating the end of the honeymoon phase of a relationship (Translator's Note).

couple of occasions, Weng Fan interjected that her term for Mr. Yang was Darling, in English, which reminded me of Song Meiling and Chiang Kai-shek, a high-profile couple that attracted much attention during the Republican Era. We also spent some time going down the list of leading personalities in Hangzhou, and when it came to Internet hero Jack Ma, both Mr. Yang and Weng Fan mentioned that they had dined with him and discussed some interesting things.)

23. *Cai: When you were thirty years old, you were about to embark on your research in gauge field theory, right? When you were sixty years old, you said that your father's friend, Mr. Zhu Ziqing, had changed Li Shangyin's poem "The sunset is infinitely good, only it's near dusk" to "But the sunset is infinitely good, why feel melancholy near to dusk?", and you thought this change was in line with your state of mind in your later years. I would like to tell you that a professor from the College of Humanities of Zhejiang University recently proved that this "only" actually meant "just like" during the Tang Dynasty, so that Mr. Zhu Ziqing did not need to change this poem. I would like to know what your special feelings were when you celebrated your ninetieth birthday. Did you write a poem?*

Yang: Yes, I have written one, and it is about to be published. (*Note: I later read this poem, a free verse poem written in English, in the English edition of Selected Papers of Chen-Ning Yang, Volume 2 (2013), which was sent by Mr. Yang and published by World Scientific Press in Singapore, reproduced below).*

On Reaching Age Ninety

Mine has been
 A promising life, fully fulfilled
 A dedicated life, with purpose and principle,
 A happy life with no remorse or resentment,
 And a long life
 Traversed in deep gratitude.

24. *Cai: You returned to Beijing ten years ago to settle there, and directed the creation of the Institute for Advanced Study at Tsinghua University and served as its honorary director. Can you tell us about your daily life now and how you divide your time between Beijing and Hong Kong? How is Tsinghua Campus today different in your mind from the Tsinghua Garden of your childhood? I know that your parents are buried in Suzhou, do you still remember them from time to time? The photo of your reunion with your father in Geneva in 1957 is moving and unforgettable. Can you tell us your secret for taking care of your body, which is still healthy and able to travel and speak? Of course, no one can avoid the laws of nature. What will your epitaph be? Do you have a particular mathematical formula that you would like to use?*

Yang: I am close to my three younger siblings, and we certainly miss both parents and everything from our childhood at times. Tsinghua Campus is the place where I grew up as a child, and my life can be said to form a circle. I started from one place, traveled far away, and now I have come back. (*Note: In 2003, Mr. Yang returned to China. Later, a small courtyard was built in Zhaolan at Tsinghua Campus as a place for Mr. Yang to live and work. He named this small building A Return*

to Roots, and wrote a poem with the same title. "Formerly responsible for a thousand searches, high on Jiuren Peak. Deep studies into symmetry, courage soaring to the clouds. The new heavens of our divine land have changed, the heavy mission of my homeland. Students aspire to the heights, I am the pine marking the trail. Three melodies of a thousand years, in the midst of talk and laughter. A new career late in years, the old man returns to the roots of his eastern fence."⁵)

25. Cai: Next year is the 50th anniversary of the discovery of Yang-Mills theory. What commemorative events will you attend? When you first discovered that quantum physics revealed a striking relationship between elementary particle physics and the mathematics of geometric objects, this prediction was later confirmed at Brockhaven in New York, Stanford, the European Institute for Particle Physics in Geneva, and Tsukuba in Japan. How come China's high-energy physics laboratory didn't do it? How many more years do you think it will take to prove the existence and mass gap hypothesis? Can it be solved within this generation of mathematicians and physicists?

Yang: It's the sixtieth anniversary. Ten years ago there was a book published for the fiftieth anniversary, edited by Gerard 't Hooft. Chinese physics is growing quickly and the future is very bright. The pessimistic view of many people is because they do not know the inside story. (Note: Gerard 't Hooft is a Dutch physicist born in 1946, known for his contributions to the development of gauge theory in particle physics, and for his doctoral thesis introducing the technique of dimensional regularization and giving a proof of the renormalizability of Yang-Mills theory; he was awarded the Wolf and Nobel prizes in physics in 1981 and 1999, and he is also a foreign member of the French Academy of Sciences and the U.S. National Academy of Sciences).

(Translated by Tyler Ross)

Use of AI tools declaration

The authors declare they have not used Artificial Intelligence (AI) tools in the creation of this article.

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Conflict of interest

The authors declare there is no conflict of interest in any part of this article.

⁵ There is a pun on the family name of Weng Fan in the last line with the character 翁, meaning *old man* or *father* (as an honorific), impossible to render in English.

Ethics declaration

The author declared that the ethics committee approval was waived for the study.

Author's biography

Dr. Tianxin Cai is a number theorist, an outstanding professor of Zhejiang University, China, as well as a poet and essayist. His works have been translated to more than 20 languages from originally Chinese, English version or French version, with 7 books in English, including *Modern Introduction to Classical Number Theory* by World Scientific in 2021, *Perfect Numbers and Fibonacci Sequence* by World Scientific in 2022, and *A Brief History of Mathematics* by Birkhauser in 2023.

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