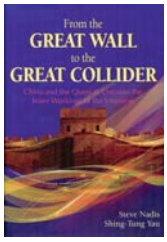
From the Great Wall to the Great Collider

China and the Quest to Uncover the Inner Workings of the Universe



Steve Nadis and Shing-Tung Yau

International Press of Boston, 2015. $29.50 (214 pp.). ISBN 978-1-57146-310-4

We are living in an era of a new China—one that has changed completely and permanently in the wake of the economic boom it experienced in the past few decades. Its ancient tranquil landscapes have been supplanted by skyscrapers connected by a network of high-speed trains. This wealthier China has also generated many noteworthy scientific discoveries with a correspondingly large number of applications. Now those involved in the nation's scientific community are contemplating the profound contributions that China—one of the oldest known civilizations—could make to our scientifically and technologically driven world.

China's glory is still largely buried in the tombs of ancient emperors. Most cities have yet to uncover their archaeological treasures—one exception is Xian, with its display of Terracotta Army soldiers from the Qin dynasty. Another visible wonder is the Great Wall of China, which was built in the course of thousands of years by many generations of Chinese. It is the single largest construction project ever completed on Earth. But the time for building walls in China has long passed and given way to new, ambitious proposals for international megascale projects.

Among them is China's plans to build a "Great Collider," a next-generation multinational particle accelerator research facility consisting of a proposed circular electron–positron collider (CEPC) and a super proton–proton collider (SPPC). Science journalist Steve Nadis and Harvard University mathematics and physics professor Shing-Tung Yau discuss that proposal in their beautifully written book, *From the Great Wall to the Great Collider: China and the Quest to Uncover the Inner Workings of the Universe*. As a professional astronomer, I find the book suitable for students and professionals in any field of physics who want to understand the new frontiers in particle physics and astronomy.

From the Great Wall to the Great Collider describes the physics that links the universe, including the particles from the epoch of the Big Bang and the ones being studied today at CERN's Large Hadron Collider. Its first three chapters are "Smashing Atoms," "Chasing the Higgs," and "Beyond the Standard Model." Throughout, abstract physical principles are intertwined with pertinent stories of their discoveries, which makes reading the book an enjoyable, engaging experience. The three chapters provide enough background material for students to understand the key concepts and predictions of the standard model and beyond and the techniques used to test them experimentally. The ideas from particle physics, in turn, are necessary for understanding such concepts as dark matter and dark energy.

The proposed accelerator facility is discussed in the next three chapters. Chapter 4, "China on Center Stage," reviews the country's historical contribution to modern physics and several of its ongoing physics experiments. The success stories of the Beijing Electron–Positron Collider and the Daya Bay Reactor Neutrino Experiment have paved the way for the brave CEPC–SPPC concept, which is discussed in chapter 5. The proposed Great Collider would be a "quantum leap," according to the authors.

In chapter 6, "The Most Amazing Spinoff of All," the authors provide several examples of how particle-physics experiments have led to technical advances that benefit society. For example, the Web, which emerged from CERN, has changed the world of communications and reshaped the global economy. It is a wonder that great companies, like China's Alibaba.com, could actually trace their roots back to CERN.

The CEPC–SPPC concept has been an international quest from the beginning. Led by Yifang Wang, director of the Beijing-based Institute of High Energy Physics, the project is expected to involve thousands of scientists and engineers from all over the world, many of whom would be working onsite in China. From that point of view, the proposal is also a quantum leap to a future in which China will help lead international efforts to understand the universe. A project of that scale is likely to change humanity in some unexpected and unpredictable ways.

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The Most Wanted Man in China

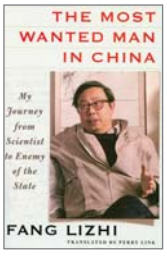
My Journey from Scientist to Enemy of the State

Fang Lizhi (translated by Perry Link)

Henry Holt and Co, 2016. $32.00 (352 pp.).
ISBN 978-1-62779-499-2

The day after the 4 June 1989 student protests that ended tragically near Tiananmen Square, Fang Lizhi and his wife Li Shuxian sought and received refuge inside the US Embassy in Beijing. It was during his embassy stay, which lasted until June 1990, that Fang penned his autobiography. It was published in Chinese a year after his unexpected death in 2012 with the title, *The Autobiography of Fang Lizhi*.

The new, English version—*The Most Wanted Man in China: My Journey from Scientist to Enemy of the State*—was edited and translated by Perry Link, who had convinced Fang and his wife to seek protection in the US embassy. It features selected parts of Fang's memoirs, and the title is markedly different in tone from the more sober one of the Chinese edition.



Unlike the scientific books by Fang and Li (also a physicist), this is a political book. It includes Fang's particularly compelling firsthand account of the dramatic events in Chinese universities during the Cultural Revolution of 1966–76. The book is beautifully written and includes many lively anecdotes. It centers on Fang and his decades-long struggle in defense of liberty, dignity, and integrity in scientific thinking—traits that earned

him the 1989 Robert F. Kennedy Human Rights Award.

Fang writes that he worked several times in the "fields" during his academic life: On four separate occasions from the 1950s to the 1970s, Fang had to abandon his physics studies in field theories to work the literal agricultural fields on rural farms. He humorously describes chasing pigs on a farm during the labor camp period, developing muscles in his chest, and later, using his physical strength to wrestle his way through the windows of packed trains for free rides during the Red Guard "revolutionary tourism" activities as head of an imaginary "combat Brigade 71 of USTC" (the University of Science and Technology of China).

We follow Fang descending deep into the mines to dig coal as part of his "re-education" at Bagong Mountain in 1969. Reflecting on a literary classic, he writes, "the famous words from the Inferno section of Dante's *Divine Comedy*: . . . 'Abandon all hope, ye who enter here.' My feeling, as I ascended with naked body from a thousand feet deep in the mine, was that the great poet had hung his sign over the wrong door." Fang, unlike Dante, testifies of events not just imagined but directly observed.

We read as well how excited Fang was to get a hold of a copy of *The Classical Theory of Fields* by Lev Landau and Evgeny Lifshitz. "Each evening as night arrived, my fatigued body retired under a net while my liberated spirit leaped toward the wide universe in pursuit of the beautiful and moving question of its ultimate origin." Fang's luck was to have laid hands on the shortest and best-written text on Einstein's theory of relativity—several sections of that Landau–Lifshitz treatise. In July of 1976, under Fang's leadership, USTC launched its astrophysics division. That year also marked the end of China's Cultural Revolution and the beginning of an era of modernization.

The book does not cover Fang's life following his departure from the US Embassy in Deng Xiaoping's car—a scene that may well be illustrated by another phrase from Dante, "And thence we came forth to see again the stars." Fang would spend his later years with his wife and relatives at the University of Arizona, teaching, researching, and vigorously encouraging international cooperation in an effort to facilitate the exchange of Chinese students, postdocs, and scientists dedicated to advanced relativistic astrophysics research. All the while, he was planning his eventual return to China on his Chinese passport.

In October 2011, at the 3rd Galileo-Xu Guangqi Meeting in Beijing, I learned that Fang's research articles were again being published in China. He was greatly pleased to hear that. Fang worked up to the last minutes of his life, discussing over Skype the organization of the 13th Marcel Grossmann Meeting in Stockholm, which took place two months after his death.

There I commemorated Fang and also recalled a few historical events. The Nobel laureate Abdus Salam had established good relations with Chinese premier Zhou Enlai. Enrico Fermi's former students, Nobel laureates C. N. Yang and T. D. Lee, were responsible for the massive program of sending thousands of young Chinese students and scientists to study in American universities. Salam, Yang, and Lee arranged for the Chinese Academy of Sciences to invite me to

China in 1978. Fang was appointed as my guide. He and I gave lectures all over the country on the new results on black holes, gravitational waves, and cosmology—in universities that still showed scars from the Cultural Revolution.

I also recalled how Zhou Peiyuan, president of Peking University, had arranged on behalf of the academy to hold the 3rd Marcel Grossmann Meeting (1982) in Shanghai. It was the country's first truly international meeting, thanks in part to Zhou's facilitating the admission of Israeli scientists into China. The Confucius-inspired saying, expressed as "friends from all over the world are welcome," acquired a more modern version, "scientists from all over the world are welcome."

All those events helped to promote China's momentous transition from a closed country, constrained by a dogmatic application of Marxist rules and lacking the methodology to approach real social necessities and scientific knowledge, to the China of today, characterized by its tremendous support for science, the pursuit of knowledge, and technological development admired all around the world.

I don't know if Fang would have liked the title of this book. In an interview of him by our common friend Tiziano Terzani, Fang was asked, "Your name was put at the top of the 'most wanted' list in China. You might not like to be called 'conspirator,' but would you accept the term 'inspirator'?" Fang's reply: "Yes. This is a label I have to accept."

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Statistical Mechanics and Applications in Condensed Matter

Carlo Di Castro and Roberto Raimondi
Cambridge U. Press, 2015. $79.99 (544 pp.).
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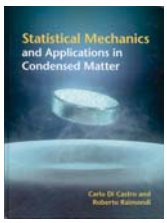

Science educators and students alike have long struggled to answer the question, "What textbooks will help me learn that?" In condensed-matter theory, the problem is aggravated by the fast and turbulent growth of new, exotic subjects, whose substance, meaning, and connection to the standard theories enshrined in venerable texts are often unclear to the unsavvy.

Carlo Di Castro and Roberto Raimondi's *Statistical Mechanics and Applications in Condensed Matter* answers the question and effectively fills a good part of the theory gap in conventional texts for the lively area of research that involves condensed-matter physics, many-body theory, and quantum statistical mechanics. The authors, whose competence is beyond doubt, employ a well-considered approach to bridge background statistical mechanics topics, standard condensed-matter physics applications, and a limited but inspiring choice of advanced and timely many-body themes.

The first seven chapters offer a self-contained presentation of introductory statistical mechanics, both classical and quantum, starting from basic thermodynamics. In subsequent chapters, readers with a particular interest in phase transitions and equilibrium critical phenomena can learn about such approaches as mean-field theory, Landau theory, scaling, and the renormalization group. The authors deliver a well-designed exposition of quantum many-body phenomena before moving on to explanations of superconductivity, superfluidity, and the general properties of Fermi liquids. That exposition prepares the reader for the ensuing discussion of such advanced topics as the microscopic foundations of Fermi liquids, the Tomonaga–Luttinger model for one-dimensional systems, Anderson localization, and weak-localization phenomena. Compact yet effective presentations of thermal Green's function diagrams and Feynman diagrams—traditional tools of the many-body theorist—are applied to modern and advanced aspects of condensed-matter theory, in particular, to interactions in disordered fermionic systems.

The authors acknowledge making a deliberate choice not to include everything that is new, or hot, or even important, such as the quantum Hall effect, or some of the wonders of Mott physics, noise physics, and topological insulators. Indeed, those subjects are already well covered in recent books and reviews. However, Di Castro and Raimondi do present some recent developments that are rarely found in course texts. For instance, their treatment of the fluctuation-