

Research on the Mathematical Achievements of Famed Mathematician Jiang Zehan in China

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ABSTRACT: Jiang Zehan, an academician of the Chinese Academy of Sciences, is a famed mathematician who made great contributions to the development of mathematics in China in the last century. In order to develop the study of his good practices, several scholars have studied him previously. Through the analysis of these studies, it is found that the existing studies mainly focus on his academic research, educational reform, and translation achievements. Some of these aspects have been studied in depth respectively, however, these studies are not comprehensive and sufficient. Therefore, it is suggested that the follow-up research should continue to expand these studies, and meanwhile, pay attention to the research on Jiang's methods for guiding students to learn mathematics, his academic functions to promote the development of mathematics in China, the influence of his academic achievements abroad, and the development of his academic level.

Keywords: Jiang Zehan, Mathematics, Education, Topology

I. INTRODUCTION

Jiang Zehan (1902-1994), born in Jingde County of Anhui Province in China, is a professor at Peking University, an academician of the Chinese Academy of Sciences, and a famous mathematician of the last century in China (Hu, 1994). He was born in troubled times and lived very hard, but he has a great ambition to develop mathematics research and mathematics education of China. So he devoted his whole life to them and made great contributions to the development of mathematics in China (Guo, 2003). He not only taught rigorously and methodically but also had the quality of diligence, approachability, and helpfulness, so he obtained a high reputation and prestige in the field of mathematics in China and abroad (Editorial Committee of Mr. Jiang Zehan's Memorial Collection, 1998). To gain valuable experience from the research and work of Academician Jiang Zehan, to actively respond to the national requirements for the development of science majors such as mathematics, and to promote the further development of mathematics research and education in China, the research on Academician Jiang Zehan has received extensive attention, so many research results came out continuously in recent years. To obtain more valuable results from the research on Academician Jiang Zehan so that the development of mathematics research and mathematics education in China could become more rapid, we intend to sort out and analyze early research.

II. LITERATURE SOURCE AND CLASSIFICATION

We searched for papers with the Chinese keyword "Jiang Zehan" on the China National Knowledge Internet, and 72 related works were found; we searched on the Baidu Academic Internet, and 664 works were found; then we searched on the Google Academic internet, and 552 works were found. Next, we also searched with the English keyword "Jiang Zehan" on Google Academic internet, and 1440 works were found. It can be seen that there is much literature on Academician Jiang Zehan at present.

After checking these works, we divided them into the following categories: 1. The works on the life story of Academician Jiang; 2. The works on Academician Jiang's academic research; 3. Academician Jiang's academic papers, treatises, and general articles; 4. Comprehensive literature (including retrospective and commemorative literature). Most of them aim at analyzing and reviewing the life of Academician Jiang.

With the purpose to summarize the research of Academician Jiang Zehan's mathematics-related work, we will analyze the literature about Academician Jiang's academic research and mathematics education.

III. RESULTS

The previous researchers who studied Academician Jiang's mathematical achievements have mainly focused on the following three aspects: Academician Jiang's academic research, his mathematical education reform, and his mathematical translation.

3.1 Academician Jiang's academic research

Concerning Professor Jiang's academic research fields, Jiang, the younger brother of Professor Jiang (2022), Wei, a history professor at Nanjing University (2017), and his students Sun, Leng, Liao, Cheng, and Academician Jiang (1983), and Chen (2012) out that Academician Jiang's academic research focuses mainly on three aspects, namely, critical point theory, covering space and fiber bundle, and fixed point theory.

In the area of critical point theory, Academician Jiang focused on Morse's critical point theory. His main contributions are as follows: He analyzed systematically the topological characteristics corresponding to their distribution types. Additionally, he proved two theorems by himself: (1) If there is a homeomorphic region, then a Green function whose inner point is a pole has a critical point in it; (2) On the plane, if R is a reconnected m dimensions region with smooth boundary, the Green function of R with any inner point as the pole point has $m-1$ critical points inside (Sun et al., 1983; Chen, 2012).

In the area of complex space and fiber bundle, Academician Jiang focused on the relationship between non-orientable manifolds M and its orientable bivariate complex \overline{M} , and proved two theorems: (1) Any class of orientable complex M must be a complex of \overline{M} ; (2) The orientable manifold \overline{M} has an anti-oriented homeomorphism without fixed points with a period of 2 (Sun et al., 1983; Chen, 2012).

In the area of fixed point theory, Academician Jiang focused on the promotion of Nielsen's theory, and successfully defined the circumference compactification of the universal complex of the surface by using the parent element of the basic group of surfaces, and proved that it is homeomorphic to the compactification obtained from non-Euclidean geometry. Since then, Jiang and his student Jiang Boju proposed the concept of the endomorphism of self-mapping, which proved the endomorphism invariance of Nielsen numbers.

3.2 Academician Jiang's mathematical education reform

After returning to China from the United States in 1931, Academician Jiang worked in the Department of Mathematics of Peking University for a long time (Jiang, 1991). In order to improve the education and teaching in the Department of Mathematics of Peking University at that time and to further improve the quality and level of teaching, Academician Jiang adopted a series of work: 1. He adopted a follow-the-lead teaching model, modeled on the system of European and American universities; 2. He developed a completely new teaching program, that is, elective courses were added to the required courses; 3. Students could not only study in classes but also carry out research work; 4. Teachers and students were free to participate in discussion classes according to their interests; 5. Foreign experts were frequently invited to lecture at Peking University; 6. He managed students comprehensively and strictly, held classes and made textbooks personally (Jiang, 2021; Ding et al., 1993; Guo, 2015).

To make this plan practical and effective, Academician Jiang also spared no effort to practice it personally. Academician Jiang personally taught many classes including calculus, advanced algebra, differential equations, advanced geometry, differential geometry, topology, and point set topology (Fang, 1994). In April 1932, Academician Jiang invited mathematician W. Blaschke to give a lecture at Peking University. Since then, numerous foreign experts have been invited to give lectures at Peking University. In 1939, the topology course started at Southwest United University. In the same year, the topology seminar was held with Chen Shengshen, Cheng Yuhuai, Liu Jinnan and others. Since then, Academician Jiang has held many seminars. To make students a good foundation for learning, Academician Jiang translated the book *Topology* written by H. Sha Aifu for 10 years and finally completed it in 1947, as well as the book *Geometry Basis* written by Hilbert which was completed in 1955. In 1964, he wrote the book *Euler Theorem of Polyhedron and Topological Classification of Closed Surfaces* for middle school students. In 1984, at the age of 83, he completed the translation of the book *The First Concepts of Topology* (Hu et al., 1994).

3.3 Academician Jiang's mathematical translation

To help students learn topology well, Academician Jiang translated the *Topology Textbook* prepared by German mathematicians Schaefer and Schleifer into Chinese (Hu et al., 1994; Editorial Committee of Mr. Jiang Zehan's Memorial Collection, 1998). Zeng, a scholar of the Chinese Academy of Sciences (2020), made an in-depth analysis of this translation and published an article *An Analysis of Jiang Zehan's Translation of Topology*. According to this study, Academician Jiang's translation is not only faithful to the original text, but also concise and clear, easy to understand, and easy to read, showing a very professional translation level. Zeng Hui said that the base text of *Topology* is the *Textbook of Topology* including 12 chapters and 87 sections prepared

by German mathematicians Schaefer and Schleifer. Comparing the contents of the two books, it can be found that the chapters of the two books are completely consistent, and the contents are not deleted. The symbols, figures and formulas in the translated book have remained the same as in the original book, only with different typography. The examples and exercises in the translated book are also highly consistent with the original book in terms of content and structure. However, the translated book is written in vernacular, with concise and clear words, which makes it easy to understand and read the book.

Additionally, there are many innovations in this book. Of particular note is that he gave numerous new translations of mathematical terms, such as homeomorphism, subgroup, torus, closure, homology group, basic group, complex form, position space, simple compound form, etc., achieving localization of foreign mathematical terms. And he also translated many sentences expressed in German according to the language habits of Chinese. For example, the theorem “dann gibt es für jedes δ der Folge $\frac{1}{2}, \frac{1}{3}, \dots, \frac{1}{i}$, einen Punkt P_i ” is translated into “Therefore, when $\delta = \frac{1}{i}$, $i = 1, 2, 3, \dots$, there exists a point P_i .” (Zeng, 2020)

IV. DISCUSSION

Academician Jiang Zehan has played an important role in promoting the development of higher mathematics research and mathematics education in China in the last century. There have been many studies on his related mathematics work in the previous. By reviewing and sorting out these studies, we can find that the previous research mainly involves Academician Jiang's academic research fields and his reform of mathematics education and his mathematics translation.

Among them, the study of Academician Jiang's translation work is relatively in-depth - the previous studies have proofread the contents of his translation of a book and analyzed the symbols, contents, formulas, examples, exercises, nouns, and languages used. The other two aspects are not very deep, especially his work on mathematics education reform. Regarding the reform work of mathematics education, previous studies list some measures and practices of Academician Jiang at that time and briefly explain the effects achieved, without in-depth analysis and exploration.

As a matter of fact, from the perspective of studying people in the history of science and technology, finding out their experiences and lessons, and finding out the laws, to promote the development of relevant disciplines in the future, the existing studies are still very inadequate. Even the relatively in-depth research on Academician Jiang's translation work is not enough, because no one has studied Academician Jiang's translation of the famous American mathematical historian Klein's *Mathematical thought: from ancient to modern times*. At least four aspects of Jiang's research should also be taken into account in the future.

1. Research on Academician Jiang Zehan guiding students to learn mathematics. Academician Jiang has guided many students to learn mathematics in his life, such as Li Shenghua, Wang Xianghao, Jiang Boju, Luo Shuangquan, Shi Genhua, Wang Shicheng, Liao Shantao, Xue Tong, Xiao Boji, Hu Bingsheng, etc. (Editorial Committee of Mr. Jiang Zehan's Memorial Collection, 1998). They have made great achievements and become leaders in their fields (Jiang et al., 2019). Jiang Boju and Wang Shicheng were also elected as academicians of the Chinese Academy of Sciences (Chen, 2017). So does Academician Jiang have any special teaching methods? It has been mentioned in the literature that Academician Jiang treats students and assistants very strictly and frequently organizes seminars to let students participate in discussions, and often invites foreign teachers to give lectures to expand students' horizons, etc. But these measures are also frequently used by other professors, especially now - these measures have become the necessary method for almost all math teachers to teach students currently. However, it is obvious that many current math teachers are far less effective than Academician Jiang in guiding students. So what valuable experience does Academician Jiang have in guiding students to learn mathematics? There is still little research in this area by now. However, this research is undoubtedly of great value and significance.

2. Research on Academician Jiang Zehan's role in promoting the development of mathematics in China. Academician Jiang has occupied many important positions in the Chinese mathematics circle in his life, such as the member of the first council of the Chinese Mathematics Association, a member of the department of mathematics and physics of the Chinese Academy of Sciences, and the chairman of the Beijing Mathematics Association, and he has been widely respected by the academic community and his role in the development of mathematics in China is non-ignorable (Hu et al., 1994). So what role did Academician Jiang play specifically? What experiences are worth learning from his work and role? There is also very little research in this field currently. China needs to develop mathematical research continuously and rapidly, especially today when science and technology are developing rapidly in China. Only by carefully summarizing the work experience of Academician Jiang can Chinese make the development of mathematical research and scientific research go more smoothly in the future.

3. Research on Academician Jiang Zehan's academic influence abroad. Academician Jiang has published

many papers in his life including important academic works *Fixed Point Theory* and *Introduction to Topology* (Editorial Committee of Mr. Jiang Zehan's Memorial Collection, 1998; Song, 2021). Academician Jiang's academic achievements were of high level at that time - the theorem proved was called "Jiang Zehan's theorem" by foreign scholars, and Academician Jiang's team was internationally known as the "Chinese topological school" (Jiang, 2002). In other words, these achievements have been spread abroad (Xu, 2002; Anonymous author, 2021). So, what is the impact of these achievements abroad? Have they been widely disseminated? These questions have not been clarified. And it is very valuable to figure out these questions, which are of great significance for China's mathematical research to step out into the world and make China develop into a strong country in mathematical research.

4. Research on the development of academician Jiang Zehan's academic level. According to his biography, Academician Jiang returned to China in 1931 and was elected as the first council member of the Chinese Mathematical Association in 1935, was the head of the Department of Arithmetic of the Southwest Union University in 1938, was a researcher of the Institute of Mathematics of the National Academies of Sciences in 1941, was a researcher of the Institute of Mathematics of the Academies of Sciences in 1947, was the vice chairman of the first council of the Chinese Mathematical Society in 1951, was a He was elected as a member of the first batch of the Chinese Academy of Sciences in 1955 (Hu et al., 1994). It can be seen from this that Academician Jiang's academic achievements accumulated continuously for more than 20 years after his return to China, meanwhile his academic level improved gradually and soon reached the highest level. What is the pattern of academic development of Academician Jiang in this that is different from others? This question has not yet been studied. The discovery of this pattern is undoubtedly an important inspiration and reference value for the promotion of mathematical research in China today.

V. CONCLUSION

The previous review and analysis of the previous research on academician Jiang Zehan's mathematics show that the existing research mainly focuses on academician Jiang's academic research fields and contributions, mathematical education reform, and translation work. However, the research on these three aspects is still relatively superficial. Therefore, it is suggested that the subsequent studies should continue to study the work of Academician Jiang in these three areas in depth.

Additionally, Academician Jiang has engaged in a lot of work his whole life, and his achievements are not only in mathematical research and engaging in mathematics education, but also many other aspects. It is suggested that future research should pay more attention to the following four aspects: the research on Academician Jiang's guiding students to learn mathematics, the research on Academician Jiang's role to promote the development of mathematics in China, the research on the impact of Academician Jiang's academic achievements abroad, and research on the development of Academician Jiang's academic level.

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