

Personal Statement

“Why is there a limit of speed in our universe?”

“You really never heard of a photon, a massless particle?”

“No way! If it works, a man could travel to the past and kill himself!”

Discussions like this occurred almost every day between my friends and myself when we were merely 12-year-old schoolboys, sharing G. Gamow’s fantastic book *One Two Three...Infinity*. Whenever I gazed upon something later, I couldn’t help wondering what elegant laws that govern its operation might be hidden. A craze also followed wherein I devoured everything I could find about science in my home and the nearby bookshop. Guided by pure interests, a nascent idea of becoming a physicist began to bud in my heart. Since I am used to devoting myself to the realization of a goal once it is set, I worked diligently throughout my high school years, with a special focus on math and physics. As a Chinese Physics Olympiad award winner, I was admitted to Peking University to further actualize my career goal of conducting research in physical science.

Although my GPA suffered a bit from physiological inadaptation at first, I never stopped working hard, and improvement has been made every year. Knowing that research is a long, hard battle, I also set demanding requirements of physical exercise for myself and haven’t even caught a cold for two years. In my junior year, I have begun the study of several graduate courses like Advanced Quantum Mechanics, Group Theory, and Surface Physics in order to place myself closer to the frontier of modern science.

My actual research experiences began with the superstar material, graphene, under the supervision of Prof. Zhongfan Liu in the College of Chemistry and Molecular Engineering.

Starting from learning how to properly hold tweezers, I gained hands-on experience in controllable Chemical Vapor Deposition (CVD) growth of graphene and its transfer between substrates. By slightly modifying the traditional CVD method, we realized the stable synthesis of twisted bilayer graphene. This work, as a patent *Multilayer Graphene and Its Synthesis Method*, has been received by the China Patent Office. Later, I developed the image-processing procedure to support a hole-etching based method to identify polycrystalline graphene domains with optical microscopic images.

With enhanced experimental skills, I joined Prof. Jian Wang's group specializing in scanning tunneling microscopy (STM). Through massive literature reading, I grew familiar with the basics of STM and its applications in the study of high-temperature superconductors. I developed the know-how about quasiparticle interference (QPI) analysis, wrote the analyzing code, and applied it to one-unit-cell FeSe/SrTiO₃ to provide concrete evidence for orbital selective Cooper pairing. I also wrote the drift-correction program and formed a better understanding of the experiment errors unique to STM. We have collected the results into a paper, *Orbital Selective High-Temperature Cooper Pairing Developed at the Two Dimensional Limit*, which will be submitted to *Nature Physics*. Another study I was engaged in concerned the Bernal stack (AB stack) bilayer graphene on SiC substrate. Through spectral analysis, I found weight transfer phenomena that implies electron correlations resembling Mott physics. The results are being organized into another paper.

I also strove to diversify my perspectives and academic exposure to computational study of condensed matter systems, especially first-principle calculations. Now I have mastered the use of *Vienna Ab-initio Simulation Package* and have some experience with *Linux* operating

system. Through an investigation of the existing correction schemes for the calculations of charged defects with periodic cells, I gained a taste of how people in the computation community do things. Now I am working, under the guidance of Prof. Ji Chen, to provide the Python code integrated with other libraries, which may facilitate a more convenient correction procedure.

While experimentalists work in the top-down way by relating observed phenomenon to microscopic mechanisms, what computation does is to construct elegant micro-models to deduce the emergent behavior of a complex system, thus in a bottom-up fashion. I find both working ethics fascinating in their unique ways.

All these experiences nurtured my juvenile love of physics so that it matured and evolved into unwavering faith and enduring pursuit. I have prepared myself with both experimental and computational skills, enabling me to delve deeper into the area of condensed matter physics. The tactful communication and collaboration skills that I have developed through working in different groups help me to quickly adapt and learn. The working experiences will equip me with the ability to combine different approaches when challenging even the hardest problems.

(Shan Zhong)