The School of Physical Sciences at the University of the Chinese Academy of Sciences

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Located in Beijing, the University of the Chinese Academy of Sciences (UCAS), is a higher education institution under the direct leadership of the Chinese Academy of Sciences (CAS), which is the hub of China's drive to explore and harness high technology and the natural sciences. The predecessor of UCAS was the Graduate University of the Chinese Academy of Sciences (GUCAS), which was founded in 1978 as the first graduate school in P. R. China. It held many "firsts" in the new China: the first doctoral degree in science, the first doctoral degree in engineering, the first female student to be awarded a doctoral degree, and the first research student to be awarded a double doctoral degree in China were all from GUCAS.

In June 2012, GUCAS was renamed UCAS. The "fusion of scientific research and teaching" has become the guiding strategy for CAS since that time. This strategy has been actualized through in-depth cooperation and integration between CAS institutes and UCAS in the areas of management systems, faculty members, training systems and scientific research, as well as by having shared responsibilities of management and education. UCAS boasts a team of highly qualified faculty consisting of distinguished researchers from CAS institutes and full time professors. As of today, UCAS has 442 full-time faculty members, and 2,599 "dual-employed" professors, who are employed by both CAS institutes and UCAS. There are also 11,721 supervisors for graduates, including 283 CAS Academicians and 6,432 doctoral supervisors. The majority of the supervisors are full-time researchers from CAS institutes.

Being the largest graduate education institution in China, UCAS' focus has long been graduate education. UCAS is authorized to confer master and doctorate degrees in all science disciplines and 90% of the engineering disciplines. It is also authorized to confer professional master' s degrees in disciplines such as engineering, business administration, finance, applied statistics, applied psychology, translation and interpreting, agricultural extension, pharmacy, engineering management and public management. From 1980 to 2016, UCAS had conferred degrees to 139,684 students, including 67,544 doctoral candidates and 72,140 master candidates. Ninety-one graduates of UCAS were selected to become Academicians of the Chinese Academy of Sciences (CAS) and the Chinese Academy of Engineering (CAE), the highest honorific titles in science and engineering in China, respectively.

In 2014, UCAS began to recruit undergraduates, aiming to cultivate innovative leading talents in science and technology for the future of the nation. Each year, less than 400 high school graduates will be carefully selected by the university; only those with determination to devote themselves to scientific research and received very high scores (usually the top 0.05% in their provinces) in college entrance exam will be accepted by UCAS. As of the spring semester of 2017, there were totally 1058 undergraduates registered in this University.

Fig. 1: The Library building of UCAS' Yanqihu Campus.

UCAS has four campuses located at Yuquanlu, Zhongguancun, Olympic Village and Yanqihu respectively, and all are equipped with libraries, teaching and research facilities. In addition, UCAS students all have full access to the collections and electronic literature database of the National Scientific Library at CAS. Students can also immerse themselves into the libraries for all of the institutes or the branches of CAS for the literature of their specific field.

Leveraging CAS' extensive resources on international scientific cooperation, UCAS has established close ties and partnerships with Columbia University, the University of California, Santa Barbara, École Polytechnique Fédérale de Lausanne (EPFL), Australian National University, the Max Planck Society in Germany, the National Center for Scientific Research in France, the Russian Academy of Sciences, the National Academy of Sciences of the United States and many other world-renowned universities. It has jointly established the Sino-Danish College in China with the Danish Ministry of Science and Education and eight Danish public universities.

HISTORY OF SCHOOL OF PHYSICAL SCIENCES

The School of Physical Sciences at UCAS developed from the Physics Teaching Section at GUCAS. In March 1978, in an effort to provide consistent and high-quality lectures for research students of various Beijing-based CAS research institutes, the establishment of a strong body of full-time faculty members was deemed necessary; it had also made the process of inviting well-known Chinese and foreign scholars to teach as guest lecturers smoother. The Physics Teaching Section of GUCAS began to take shape rapidly, and by 1979 it had built a full-time faculty with over 20 professors.

In 1979, the Physics Teaching Section invited Prof. Lee Tsung-Dao to teach two lecture courses: particle physics and statistical mechanics. These lecture series had a profound influence, attracted many well-known Chinese scientists and lecturers from top universities as well as graduate students to register. Around the same time, the department also invited Prof. Peng Huanwu to teach a course on Theoretical Physics, Prof. Huang Kun and others to teach Solid State Physics, and Prof. Yang Chen-Ning to teach Field Theory. These eminent scientists laid a solid foundation for the training of excellent physicists.

Since its inception, much care and devotion has been given to the Physics Teaching Section by the older generation of scientists: for example, our former vice dean, Prof. Yan Jici, despite advancing years, frequently participated in research and teaching meetings; Prof. Zhu Hongyuan and Prof. Ma Dayou also acted as consultants. Each of them, in the midst of their busy schedules, took time to give much valuable advice and guidance to the fledgling team.

In 1985, GUCAS underwent organizational changes. On top of teaching and research, the Physics Teaching Section became responsible for the administration and man-

agement of all CAS's graduate students in physics, hence the name was changed to the Physics Teaching Division.

In 1995, the handbook "Graduate Student Curriculum Design and Contents" was published. It provided a detailed illustration of the Graduate School's curriculum and standard of teaching in China; among the courses listed, physics courses from GUCAS had consistently reached top national rankings. The Physics Teaching Division continued to strive to attract the best students and raise the quality of training. In 2006, the ever-expanding Physics Teaching Division was renamed again to become the School of Physical Sciences.

With the "fusion of scientific research and teaching" becoming the guiding strategy for CAS in 2013, the organizational structure of UCAS also changed accordingly. In January 2015, the "fused" School of Physical Sciences was re-structured and undertaken by Beijing based CAS Physics Institutes, namely by the Institute of Physics (IOP), the Institute of High Energy Physics (IHEP), the Institute of Theoretical Physics (ITP), the Institute of Semiconductors (SEMI) and the Institute of Acoustics (IOA). The school is also supported by several other relevant institutes outside of Beijing, such as the Institute of Modern Physics (IMP) in Lanzhou, the Institute of Applied Physics (SINAP) in Shanghai, and the Institute of Optics and Fine Mechanics (SIOM) in Shanghai.

FACULTY AND DIVISIONS

Empowered by the "fusion of scientific research and teaching" strategy, the school of the Physical Sciences developed an organizational subdivision, the "School-Department-Teaching and Research Sector". It is comprised of the Department of Physics, the Department of Modern Physics, the Experimental Physics Teaching Lab and 10 teaching and research sections.

The Department of Physics and the Department of Modern Physics are led by IOP and IHEP respectively; they are responsible for the teaching and management activities and it is managed through the Teaching and Research sections. The Department of Physics is composed of seven teaching and research sections: basic physics, theoretical physics, atomic molecular and optical physics, condensed matter physics, interdisciplinary and applied physics, acoustics, and semiconductor physics. There are three teaching and research sections in the Department of Modern Physics: experimental particle physics, theoretical particle physics and nuclear science and technology.

The administration, academic board, teaching committee and teaching steering committee are led by distinguished CAS Academicians. The current director of the school is Prof. Gao Hongjun; the current chairman of the academic board is Zhao Zhongxian; the current head of the teaching committee is Prof. Xiang Tao; and the current the head of Teaching Steering Committee is Prof. Wang Weihua.

There are two types of faculty in the school: "dual-employed" faculty members, and full time faculty members. "Dual-employed" faculty members are employed by one of the CAS institutes and one of the teaching and research sections, whereas a member of the full time faculty is employed solely by the school. The school's highly qualified faculty consists of 241 "dual-employed" faculty members and 26 full time faculty members. There are 33 CAS Academicians and 66 "Distinguished Young Scholars" fellowship receivers among the 267 renowned faculty members. More than ten of them were selected as American Physical Society Fellows.

In recent years, the school's faculty members have received some of the most prestigious awards in the nation as well as in the global physics community : the Daya Bay Neutrino Experiment led by Prof. Wang Yifang won the 2016 Breakthrough Prize in Fundamental Physics; Prof. Xie Jialin and Prof. Zhao Zhongxian won the 2011 and 2016 Highest National Prize of Science and Technology respectively; Prof. Zhao Zhongxian and Prof. Wang Yifang won the 2013 and 2016 First Class Award of State Natural Science Award respectively, just to name a few. These had made profound impact on the development of the subject of Physics and Physics researches in China.

PHYSICS EDUCATION

"Leveraging the cutting-edge research platforms to breed outstanding talents" is an underlying principle of the School of Physical Sciences.

CAS embraces the majority of the state-of-the-art large-scale scientific facilities in the nation such as the Beijing Electron–Positron Collider (BEPCII) and the Beijing Spectrometer (BESIII), the Daya Bay Reactor Neutrino Experiment (Daya Bay), the Heavy Ion Research Facility in Lanzhou (HIRFL), the Shanghai Synchrotron Radia-

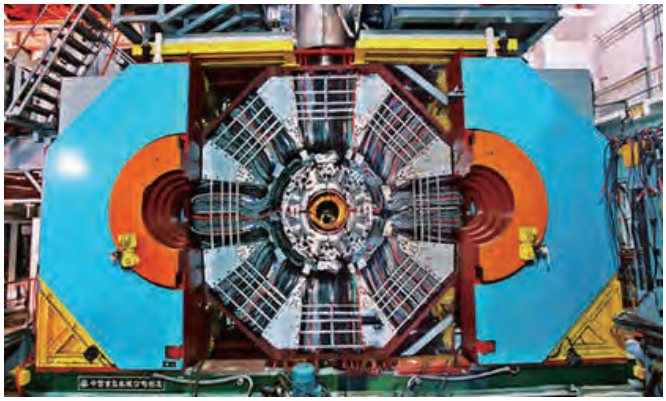

Fig. 2: BES III, a general-purpose detector based at the BEPCII e+e- collider in Beijing.

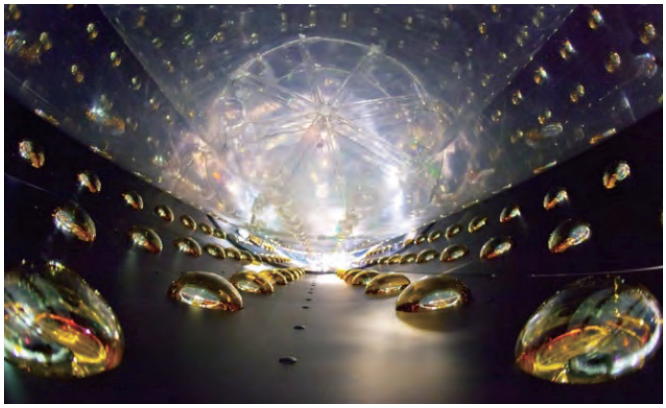

Fig. 3: One of the Daya Bay detectors.

tion Facility (SSRF), and the China Spallation Neutron Source (CSNS). Guided by the strategy of "fusion of scientific research and teaching," those facilities indeed provide the best opportunity in scientific education and research training to physics students.

The curriculum for physics-related subjects is designed by the teaching and research sections. The curriculum then needs to be approved by the teaching committee of the school. The school aims to continually improve its standards of teaching, drawing upon recent developments in graduate-level education around the world. Besides having a full-time faculty, the school also leverage the extensive experience from numerous top-notch scholars in relevant fields who teach on a part-time basis. In addition, each year over a hundred experts from China and abroad come to give special lectures on advanced topics.

The school offers BD, MS and PhD degrees in physics and nuclear science & technology. The graduate program offers degrees in almost all of the research fields of physics, such as particle and nuclear physics, atomic and molecular physics, plasma physics, condensed matter physics, acoustic physics, optics and radio physics.

It provides more than 85 core and optional courses, and more than 40 scientific symposiums and various research training programs.

In terms of undergraduate education, the mission is to "cultivate the future leaders and the backbone of science and technology." Thus, the team of instructors for the undergraduate courses has been very carefully selected from the most distinguished faculty members. Around 80 undergraduate students majoring in physics are expected to be recruited each year. As of today, the total undergraduate major enrollment in the School of Physical Sciences is 235. Each student is assigned a supervisor, who is selected from the list of distinguished professors or full-time researchers. With 267 total faculty members, it consequently results in a faculty-student ratio of 1.1:1. Presently, the total enrollment in master's and doctoral program are 665 and 1219, respectively.

Adhering to UCAS's mission to "cultivate innovative, leading talent in science and technology for the future of the talents", the School of Physics at UCAS focuses on preparing resources for the two newly approved national strategic projects: the Beijing Huairou National Scientific Center and the Shanghai Zhangjiang National Scientific Center. As the main pillar of these two mega national scientific projects, physics will be the focal point of China's scientific research domain. As such, the School of Physics at UCAS is expected to train hundreds, if not thousands, of highly qualified, well trained young physicists in the next decades to fulfill the national's scientific goals.

RESEARCH AND SELECTED HIGHLIGHTS

Besides these aforementioned in-operation facilities, more physics related large-scale scientific facilities and research platforms are under constructing at CAS; among them are the Jiangmen Underground Neutrino Observatory (JUNO), China Spallation Neutron Source (CSNS), Accelerator-driven subcritical system (ADS), Beijing High Energy Photon Source (HEPS), and the X-ray Free Electron Laser in Shanghai (XFEL), etc. The professors and the researchers at the School of Physical Sciences are playing vital roles in the design, construction and commissioning stage for those facilities.

The faculty members and the students of the School of Physics are the core members of those cutting-edge research programs. The opportunity to be immersed in those state-of-the-art scientific programs allows our students to learn from the most talented scientists in China and international community alike; the hands-on research training empowers our students to explore the new horizons of physics and paves the road for them to reach for more and greater scientific achievements for mankind.

The school covers a wide spectrum of research areas, from fundamental research and frontier sciences to applied researches, emphasizing indigenous innovation, adhering to national strategy to tackle major research obstacles.

Some notable research achievements include the breakthrough in iron-based superconductors performance records, the discovery of a new particle with at least four quarks, the discovery of neutrino oscillation, and the observation of Weyl nodes in TaAs . The Daya Bay Reactor Neutrino Experiment research team won the Fundamental Physics Breakthrough Prize in 2016.

Selected Research Highlight: Discovery of superconductivity in Iron-and Nickel-based oxypnictides

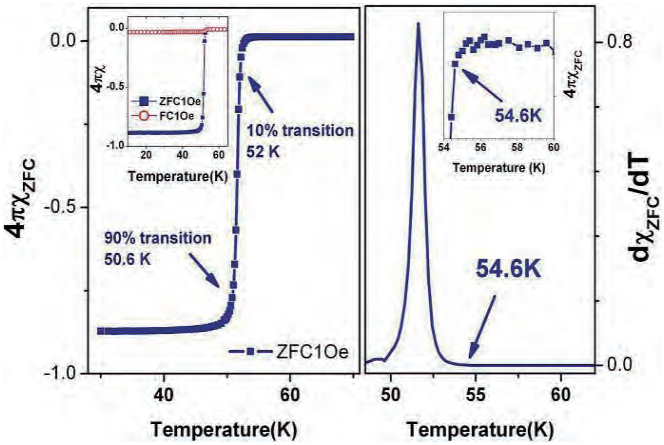

Fig. 4: Achieve the highest T_c up to 55 K in Iron- based superconductor.

In 2015, Prof. Zhao Zhongxian was awarded the Matthias prize for the discovery of RE(O,F) and (RE)O1-xFeAs (RE = rare earth) with a Tc up to 55 K, demonstrating the limit of Tc in bulk Fe-based superconductors.

Selected Research Highlight: Observation of Electron Antineutrino Disappearance at Daya Bay

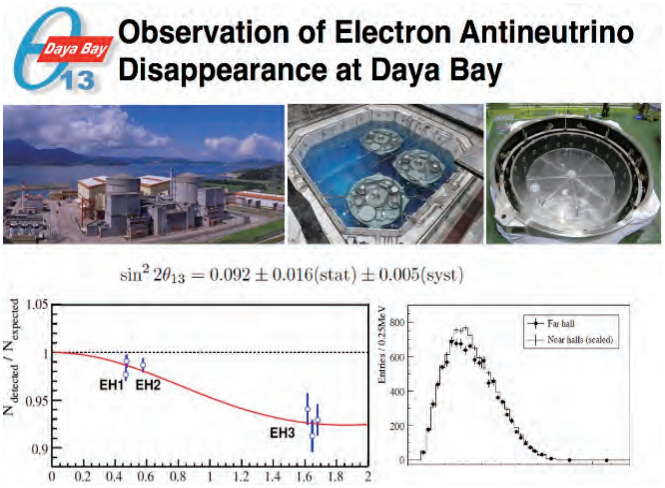

Fig. 5: A new type of neutrino oscillation was observed in Daya Bay Reactor Neutrino Experiment in 2012.

The Daya Bay neutrino experiment led by Prof. Wang Yifang observed a new type of neutrino oscillation in 2012. The copious data revealed for the first time the strong signal of an effect that the scientists were searching for, the so-called "mixing angle" named theta one-three (written θ_{13}), which the researchers measured with unmatched precision. Theta one-three, the last mixing angle to be precisely measured, expresses how electron neutrinos and their antineutrino counterparts mix and change into the other flavors. The Daya Bay collaboration's first results indicate that $\sin^2 2\theta_{13}$ is equal to 0.092 plus or minus 0.017. The collaboration hence won various prestigious awards in physics including the Breakthrough Prize in Fundamental Physics in 2016.

Selected Research Highlight: The Prediction and Observation of Weyl nodes in TaAs

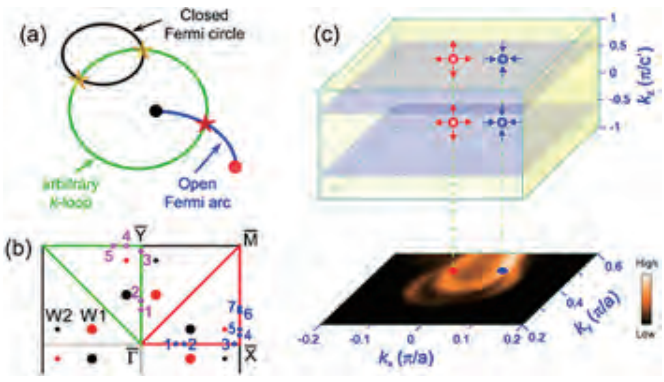

Fig. 6: shows Schematic of a closed Fermi surface circle and an open Fermi arc crossing an arbitrary k-loop in the two-dimensional case.

In 2014, Prof. Weng Hongming, Prof. Dai Xi, and Prof. Fang Zhong and their collaborators predicted that the non-magnetic and non-centrosymmetric transition-metal monoarsenide TaAs family compounds are Weyl semimetals (WSMs). This prediction was soon confirmed by several experiments worldwide. The existence of Weyl nodes in WSMs leads to the observation of a surface Fermi arc, one of the fingerprint phenomena of WSMs. These achievements provided undisputable experimental evidence for the existence of Weyl fermionic quasiparticles in TaAs. The results were selected by the American Physical Society (APS) as one of the eight highlights of 2015, and was also selected as the Physics World Top 10 Breakthrough 2015 by Institute of Physics.

Selected Research Highlight: Discovery of a series of Charmonium-like particles appear to contain at least four quarks

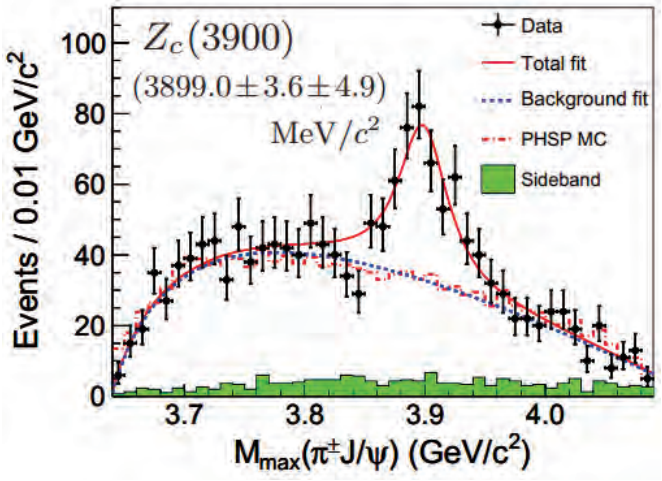

Fig. 7: Zc(3900), A newly discovered particle appears to contain at least 4 quarks.

Ordinary matter contains two or three quarks. In 2013 and 2014, at the BEPCII/BESIII Experiment, Prof. Yuan Changzheng, Prof. Zheng Yangheng, Prof. Lv Xiaorui and their teams observed a series of new particles, named Zc, which appear to contain four quarks, a pair of charm-anti-charm quarks, and a pair of lighter quarks formed an electric charge. It is believed to be the four-quark matter (an exotic hadron) that scientists have been looking for. It might provide significant information to understand the internal structure of the Zc particles, and to understand the fundamental structure of matter in the universe. The results were selected by "Physics" magazine as the first highlight of 2013.

CONCLUDING REMARKS

"A fusion of scientific research and teaching" has been the long-term strategy for CAS. Buttressed by CAS's numerous cutting-edge research facilities and huge number of top-notch scientists, UCAS is committed to turn itself into a world-class university. We warmly welcome talented young people with passion to join us in our "fused" school and together we can make more scientific achievements for the benefits of mankind. More information can be found at http://physics.ucas.ac.cn.

Professor **GAO Hongjun** received his PhD from Peking University and is currently the dean of the School of Physical Sciences at the University of the Chinese Academy of Sciences. He is an academician of Chinese Academy of Sciences and a Fellow of the Institute of Physics, UK. His research interests are in surface/interface structures and physical properties with scanning tunneling microscopy/spectroscopy (STM/STS) including molecules at solid surfaces at a single molecular level, and nano-materials and nano-electronic devices. In 2008 and 2009, he was awarded the "OCPA AAA (Robert) Prize" (OCPA: the Overseas Chinese Physics Association; AAA: Achievement in Asia Award), the "TWAS Prize in Physics 2009" (TWAS: Third World Academy of Sciences), a 2010 Humboldt Research Award and the 2012 Science and Technology Awards of the Ho Leung He Lee Foundation.