Shanghai Astronomical Observatory, Chinese Academy of Sciences

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1. HISTORY

Shanghai Astronomical Observatory (SHAO) of the Chinese Academy of Sciences (CAS) [Fig. 1], was established in 1962 following the amalgamation of the former Xu Jiahui and Sheshan observatories, which were founded by the French Mission Catholique in 1872 and 1900, respectively. Both came under the Chinese government jurisdiction in 1950.

A 40 cm double astrograph was built in 1900 on top of Sheshan hill, located 40 km to the west of Shanghai downtown which was the largest telescope in East Asia at that time. It is one of a few telescopes in the world that observed Halley's comet both in 1910 and 1986. In the 1980s, SHAO built a 25 m radio telescope [Fig. 2], used as a station for the VLBI (Very Long Baseline Interferometry) network; a 1.56 m optical telescope [Fig. 3]; and a 60 cm satellite laser-ranging system. These three facilities are still in frequent usage today for various research in the field of astrophysics, astrometry, geodynamics, satellite positioning.

In 1998, SHAO became one of the first institutions selected to implement the Pilot Program of CAS Knowledge Innovation Project. Since then, SHAO has established several new research programs both in basic and applied sciences, such as the MPA-CAS partner groups, Key Lab in Galaxies and Cosmology of CAS, Asia-Pacific Space Geodynamics Program (APSG) and Shanghai Key Laboratory of Space Navigation and Position Techniques.

SHAO also has a variety of Guest Programs which attract accomplished scientists from all over the world.

The first director of the SHAO was Professor Han Li who served from 1962 to 1981. His successor, Professor Shuhua Ye held the office until 1993. During 1993-2003, Professor Junliang Zhao directed the SHAO, and later succeeded by Professor Xinhao Liao for 2 years as a deputy director. The present director, Professor Xiaoyu Hong took office in 2005.

2. STATUS

The headquarters of SHAO is located at Xu Jiahui district of the south west corner of Shanghai city. The observational site is in She Shan. The Xu Jiahui section consists of an Astronomical Mansion of 19 floors, a laboratory building of 11 floors and a 7 floors apartment building for graduate students, post-doctors and visitors. Sufficient facilities are available, including Computer Center, Library, Lecture Halls, Seminar Rooms, Classrooms, Discussion rooms etc.

2.1. Faculty Researchers

SHAO currently has more than 200 staff, including 151 scientific and technical personnel, one academician of Chinese Academy of Sciences (CAS) and one academician of Chinese Academy of Technology (CAT). Among them, 38 are senior staff and 36 are associated researchers. Since 1997, totally 9 distinguished young research professors have been recruited from domestic and oversea under the "Program of One Hundred Talents" of CAS. And by now, there are 4 young talents have won the National Science Fund for Distinguished Young Scholars and 3 more won the overseas projects.

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In addition, SHAO initiated the post-doctoral program since 1995, and has a substantial mobile research group for post doctors. In 2006, SHAO has established a new joint postdoctoral program with Max Plank Institution for Astrophysics (MPA, Germany), aims at attracting the top level Ph.D. candidates from all over the world for their post doctor research in SHAO. At present, there are 22 post doctoral and visiting scientists working with staff in SHAO.

2.2. Organization, Research Fields

At present, SHAO has four research departments: Shanghai Center for Astro-geodynamics Research (SCAR), Center for Galaxy and Cosmology (CGC), Division of Very Long Baseline Interferometry (VLBI), and Division of High Technology Laboratories.

The SCAR engages in measurement and analysis of the plate movement of the Earth, and researches into their dynamical mechanisms, using astronomical

Fig. 1: The headquarters of SHAO in Xujiahui, Shanghai.

Fig. 2: The 25 m radio telescope in Sheshan.

Fig. 3: The 1.56 m optical telescope in Sheshan.

data. In particular, modern space geodesy techniques are used. The research topics include the rotational and orbital motions of the Earth, as well as the mass motions of the Earth's spheres, such as the atmosphere, hydrosphere, lithosphere, mantle, and core. Researchers in SCAR are also deeply involved in studies of mechanisms by which the Earth's rotation varies, and interactions between the motions of the various spheres.

The CGC was formerly the department of astrophysics, evolved from the originally second division of SHAO. During the past decades, the astrophysical research in SHAO expanded quickly by attracting active young astronomers from all over the world. The current main research fields include star clusters and the Galactic structure; formation and evolution of galaxies, large scale structure of the universe, AGN, high energy astrophysics, theory of black hole accretion and X-ray binaries. The research approaches within CGC cover from theoretical studies to observations in which numerical simulations and observations in radio and X-ray play a crucial role.

The VLBI division, consisting of the Sheshan VLBI station and the VLBI laboratory, manages the Chinese VLBI Network (CVN) of the National Astronomical Observatories of China (NAOC), which consists of four VLBI stations in Shanghai, Urumqi, Beijing and Kunming; and a VLBI data processing center in SHAO. The VLBI system joins the navigation of the Chinese Lunar project 'Chang E-1.'

Division of High Technology Laboratoires is composed by two parts: the time and frequency research center, and the astronomical optical instrumentation group. In the former research center, engineers are investigating high accuracy hydrogen masers and their applications. In the later group, scientists are designing various equipments used for astronomical observations of SHAO. At present the group is also involved in the study of a Fizeau

type interferometer for future large optical telescope in China.

2.3. Facilities and Key Laboratories

Currently, SHAO is equipped with 25 m radio telescope, 1.56 m reflector, 60 cm satellite laser ranging system (SLR), GPS receiver and hydrogen atomic time and frequency system. A new 65 m radio telescope is under construction in She Shan station, which will be the largest fully steerable radio telescope in China and shall play important role in radio astronomy and China's deep space exploration.

Numerical simulation has been one of the most important tools of astronomical research in SHAO. Presently, SHAO has a number of high performance computational facilities, including a SGI Altix 4700, Altix 350, IBM Linux Cluster. Altix 4700 and IBM Cluster have 64 and 112CPUs, respectively. SHAO also runs more than 40 servers, 200 PCs, all are linked through network. The total capabilities of computation exceed 10,000 billions.

Two Key Laboratories have been established in 2008. One is the Key Laboratory in Galaxies and Cosmology of the CAS, the other is the Shanghai Key Laboratory of Space Navigation and Position Techniques.

2.4. Graduate Education

Authorized by the Ministry of Education in 1998, as the first institution in China, SHAO can offer doctoral degree in all sub-field in astronomy, including astrophysics, astrometry, celestial mechanics and astronomical technology. About 117 graduate students are currently enrolled in SHAO.

2.5. Domestic and International Collaborations

Close domestic and international collaborations have been established during the past decades. A joint Lab for Galaxies and Cosmology was set up between SHAO and University of Science and Technology of China in 2005. A partner group of the Max Planck Institute for Astrophysics (MPA) in SHAO was founded in 2000 through an exchange program between the CAS and the Max Planck Society for the Advancement of Sciences (MPG). And in 2006, the second similar partner group started. The 25 m radio telescope is the member of European VLBI Network (EVN). It also participates the International VLBI Services for Astrometry and Geodesy (IVS), the VLBI Space Observatory Program (VSOP), the Asia-Pacific Space Geodynamics Program (APSG), as well as observations related to aerospace navigation. SHAO is also the secretariat of the Asia and Pacific regional Space and Geodetic project (APSG). The SLR station of SHAO has taken part in international cooperation program such as WPLTN, DOSE, etc.

Every year, a large number of faculty members and students visit foreign institutions and observatories, attend international conferences and schools, and observe astrophysical sources by using advanced astronomical facilities. Meanwhile, many outstanding scholars from abroad are invited to work or lecture in SHAO.

2.6. Important Scientific Progresses

A number of key scientific progresses have been achieved by researchers in SHAO during the past years. Below is just some of them:

- In the study of the planetary fluid dynamics, the Earth's nutation and polar movement, researchers in SHAO obtained analytic asymptotic solutions of second-order accuracy for convections in rapidly rotating cylinder. Several interesting phenomena of counter travelling waves in rotating annulus were found for the first time which gave possible theoretical explanation of the influence of heterogeneous lower mantle on geodynamo.

- Based on years of radio observations, SHAO scientists discovered the strongest evidence demonstrating the existence of a super massive Black Hole in our Galactic center.

- SHAO astronomers established a large scale N-body cosmological simulation program. The results show that pure N-body simulations may not suffice to accurately predict the lensing signal on small scales where cooling of the baryons starts to play a significant role and must be considered. This result has been reported by the ESA-ESO working group for fundamental cosmology in the next decade.

- A new general theory was developed for the gravitational potential and Earth's internal structure that solves the 1% problem of the global dynamical flattening. A new atmospheric angular momentum series was obtained and adopted by IERS.

- In 2007, a state fundamental research project (973) lead by SHAO scientist started. And SHAO astronomers have played the leading role in the scientific objective of LAMOST project.

3. OUTLOOK

Astronomy and astrophysics have deep roots in virtually every human culture. They help us to understand our place in the vast scale of the Universe and teach us about our origins and evolution. Great achievements have been made during the past. While there are still fundamental questions need to be addressed. SHAO will continuously play its own role in driving the progress in astronomy. We shall concentrate on a variety of research interests: fundamental researches on earth, planets, stars, galaxies and cosmology; technology development of VLBI, space navigation and positioning, SLR, timing and frequency, optical interferometer. We have reason to believe, that SHAO shall make great contributions in exploring the nature of Universe and in serving for the Nation.