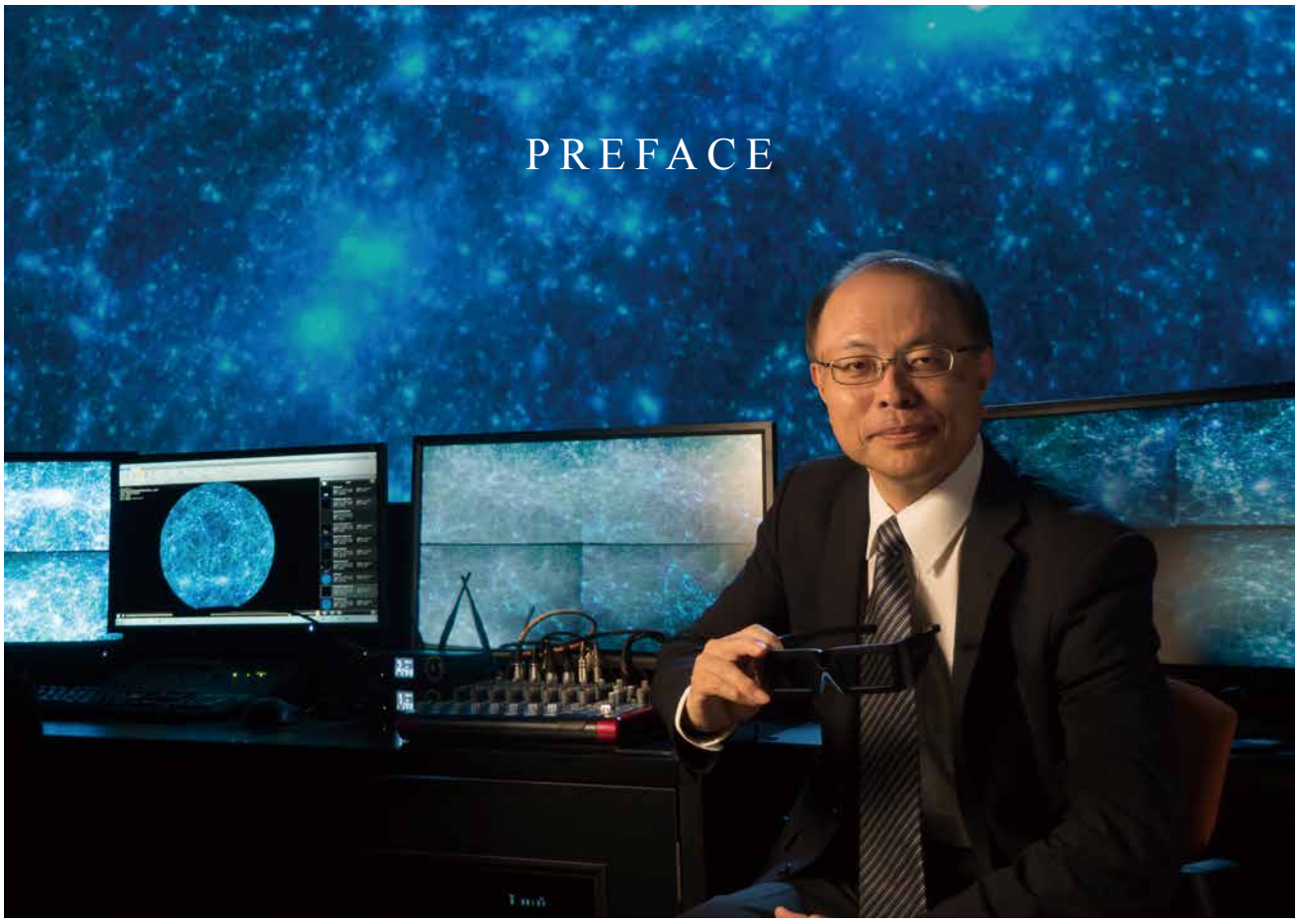
PREFACE



Masahiko HAYASHI
Director General of NAOJ

It is my pleasure to present the Annual Report of the National Astronomical Observatory of Japan for fiscal year 2014.

In February 2015, NAOJ conducted an External Review in order to evaluate our achievements over the last five years from an international standpoint. The first sentence of the evaluation report states, "The most significant development of the last five years must be the growing and highly successful Japanese participation in major international astronomical projects." This refers primarily to ALMA and TMT. With the Subaru Telescope, Japanese optical-infrared astronomy attained world leading status. But at the same time, that was also the limit of what Japan could accomplish as a single country in the field of large telescope construction. Now, NAOJ is making important contributions to major large-scale international projects, such as ALMA and TMT.

Thanks to our experiences with the Subaru Telescope, resistance in the Japanese astronomical community to building telescopes overseas disappeared. It was naturally assumed that for ALMA the radio antennas would be established overseas and that the construction and operation would be carried out as an international project. This was a new challenge for NAOJ. Fortunately as part of the reorganization and incorporation of NAOJ in 2004, the personnel system was reconsidered and the project system was established, allowing flexible reorganization to facilitate large international projects. It also became possible for individuals with valuable specialized skills to participate in large international projects as contracted staff. Furthermore, because NAOJ represents Japan in these kinds of large international projects, our obligations as an inter-university research institute are clear: to make large contributions to the advancement of research throughout all of Japan in the field of astronomy. I think the high evaluation we received from the international community in last fiscal year's External Review is a result of these changes in NAOJ's structure and philosophy.

In 2014, NAOJ's Philosophy was codified. Our Vision is "to be innovators striving to solve the mysteries of the Universe." Our Mission has 3 pillars: to develop and construct large-scale cutting-edge astronomical research facilities and promote their open access aiming to expand our intellectual horizons; to contribute to the development of astronomy as a world leading research institute by making the best use of a wide variety of large-scale facilities; and to bring benefits to society through astronomy public outreach. Our Products/Deliverables are: to explore the unknown Universe and provide new insight into astronomy; to make our research outcomes widely known to society and pass on our dreams to future generations; and to mentor next-generation researchers for their role on the world-stage.

With respect to the extremely large optical-infrared telescope TMT under construction in Hawai`i, the Master Agreement, which provides the foundation to proceed with construction within an international framework, was completed and President Katsuhiko Sato signed it on behalf of the National Institutes of Natural Sciences in April 2014. Having received this approval, the TMT International Observatory was incorporated as a nonprofit corporation in the following month (May) and a groundbreaking ceremony was held in October. TMT is a 30 m diameter optical-infrared telescope being constructed on Maunakea on Hawai`i Island by 5 countries including Japan, the United States of America (the University of California, the California Institute of Technology, and the National Science Foundation), the People's Republic of China, the Republic of India, and Canada. Japan bears responsibility for the most critical components, including the body of the telescope and production of the nearly 600 segments for the primary mirror. The search for signs of life in the Universe is one of the stated major targets for TMT. This statement sounds like a dream, but I am confident the day is approaching when it will be a reality.

ALMA is continuing commissioning (the process of confirming and adjusting the numerous devices one by one) while carrying out Cycle 2 observations. From September to November in 2014, long-baseline test observations spanning ranges of up to 15 km were conducted with surprisingly good results. Multiple concentric ring structures can be seen in the picture of the protoplanetary disk around the young star HL Tauri taken with a high angular resolution of 0.03 arcseconds. It is thought that these structures might indicate locations where planets are forming. Until now, there have been pictures drawn showing how sites of planet formation were expected to look, but an actual image is more powerful than I had ever imagined. This long-baseline capability will be offered for open use in Cycle 3, which begins in 2015. Using this, we can expect many planetary systems forming around young stars to be found rapidly in the coming years.

At the Subaru Telescope, the Strategic Science Program using the ultra-wide-field prime focus camera (Hyper Suprime-Cam) has started. This camera's survey speed (= limiting magnitude x area of the field of view) is over 10 times greater than previous surveys. What's more, thanks to this camera the Subaru Telescope's observations will be the world's forerunners without question, until LSST (America's Large Synoptic Survey Telescope) becomes operational in the mid-2020s. Observations with this camera will investigate the nature of dark matter and dark energy which determine the evolution of the large scale structure of the Universe.

Right now the Subaru Telescope is in its prime, continuously producing outstanding scientific results. In fiscal year 2014 for example, among the stars born in the early Universe, a star with peculiar chemical abundance ratios was discovered relatively close to the Solar System within our Milky Way Galaxy. This star is thought to have been formed from the gas left over after the first stars born after the Big Bang, with masses hundreds of times that of the Sun, exploded in supernovae. The first stars formed in the Universe were said to have had masses nearly 1000 times that of the Sun. But there had been no clear evidence to support that until now. These observational results provide the first proof.

The Subaru Telescope also observed a location where lithium had been produced in the gas expanding from a nova (an explosive nuclear fusion phenomenon which occurs when hydrogen accumulates on the surface of a white dwarf). Lithium, the next lightest element after hydrogen and helium, was produced in only trace amounts during the Big Bang (about one-billionth the number of hydrogen atoms). This lithium was absorbed into normal stars and destroyed in their cores. But in fact, the amount of lithium has increased as the Universe has evolved. Where this lithium was produced had been a mystery. This discovery directly verified the circumstances of lithium synthesis.

In addition to the 3 large projects listed above, VERA of the Mizusawa VLBI Observatory and the Korean KVN together formed KaVA to start joint VLBI observations. The large-scale cryogenic gravitational wave telescope KAGRA, supported in cooperation with the University of Tokyo Institute for Cosmic Ray Research and the High Energy Accelerator Research Organization, has made important progress, including starting construction of the laser interferometer.

Last fiscal year, in response to the aging of the 4D2U Dome Theater, the control computer network and projectors were upgraded. At the same time, the "3D glasses" were changed to an active shutter system. As a result, across the entire dome the image has become brighter and more vivid. Simulations of the large scale structure of the Universe or Saturn's rings can fool you into thinking that you are drifting in space. In addition, the seating capacity was doubled and it has become possible to enter without having to first remove your shoes. With these improvements, the number of days the Dome Theater is open to the public has been increased in FY 2015. So we expect more guests than ever to be able to enjoy it.

Finally, in 2014 the East Asian Observatory was founded. This was established with the goal of making a permanent basis for large international projects in East Asia in response to the increasing size and internationalization of telescope plans which I described above. The founding members are the National Astronomical Observatory of Japan; the Institute of Astronomy and Astrophysics of ACADEMIA SINICA in Taiwan; the Korea Astronomy and Space Science Institute; and the National Astronomical Observatories of the Chinese Academy of Sciences. There are still a number of unknowns about how the East Asian Observatory will develop after this. If we take as an example the European Southern Observatory, which is currently leading the world in ground-based telescope projects, we feel it is important to approach the activities of the East Asian Observatory calmly and deliberately.

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