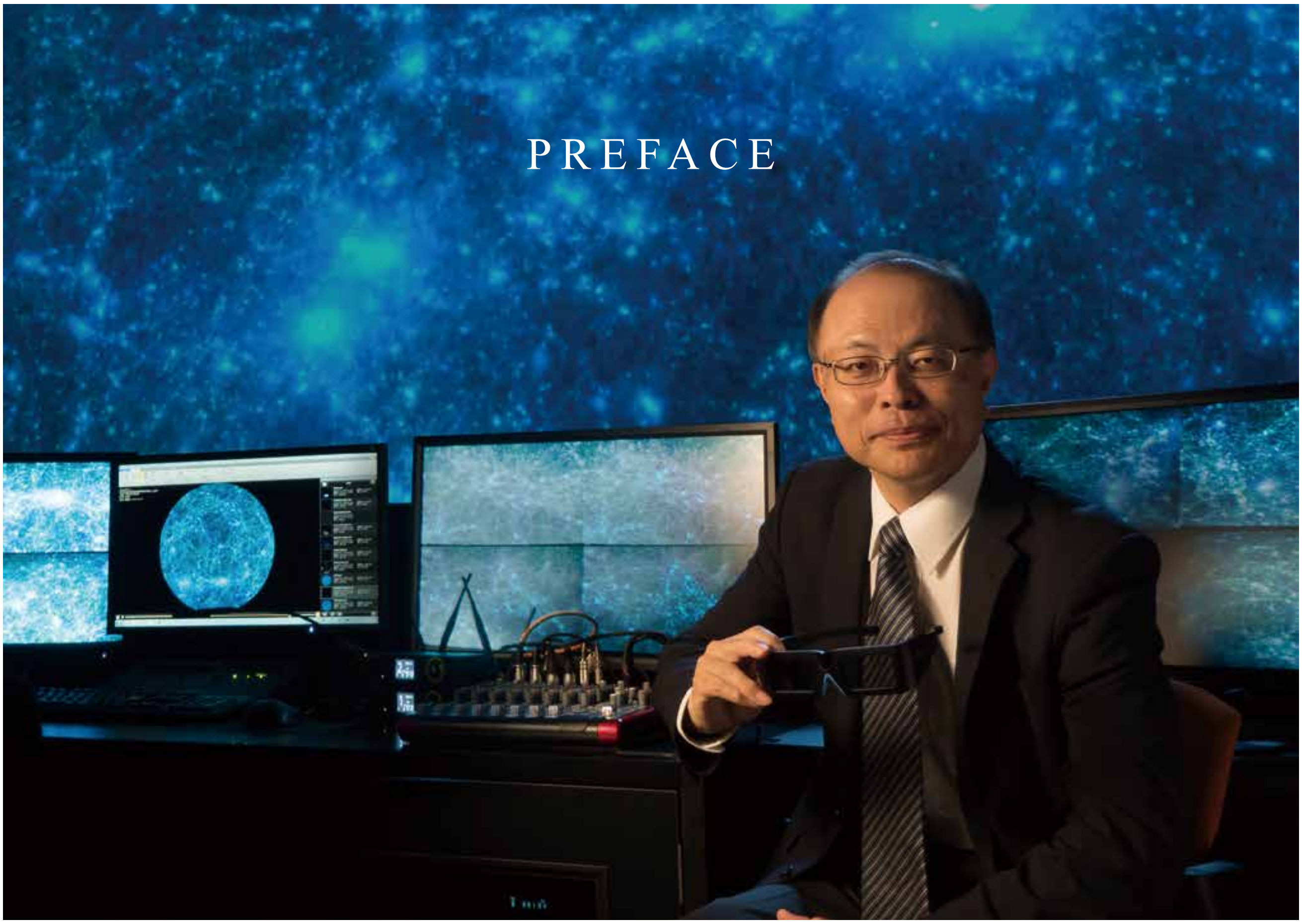
PREFACE



Masahiko HAYASHI
Director General of NAOJ

It is my pleasure to present the Annual Report of the National Astronomical Observatory of Japan.

In February of 2016, it was announced that LIGO had directly detected gravitational waves. Currently in Japan, the Large-scale Cryogenic Gravitational Wave Telescope KAGRA is being constructed in Kamioka, led by the University of Tokyo Institute for Cosmic Ray Research (ICRR) together with the National Astronomical Observatory of Japan (NAOJ) and the High Energy Accelerator Research Organization (KEK). Attempts in Japan to directly detect gravitational waves began in the 1970's with the creation of a resonant-mass detector by Dr. Hiromasa Hirakawa at the University of Tokyo. Laser interferometer type detectors started at NAOJ from the 1980's; and in the 1990's TAMA300 with 300 m arm-lengths was completed and succeeded in continuous operation. At NAOJ, making the best use of experiences like these, the Advanced Technology Center has been developing key components for KAGRA such as the end mirror vibration isolation systems, utilizing 14 m high multistage pendulums, and the main interferometer, which creates laser light interference patters with orthogonal 3 km arms. With KAGRA added to the LIGO and VIRGO gravitational wave detector network, the locations of gravitational wave sources will be able to be determined with a precision of a couple of degrees. Follow-up observations by electromagnetic telescopes will further advance this research, giving us detailed insight into the nature of black holes and neutron stars. Multi-messenger astronomy has already begun.

ALMA started Cycle 4 observations from October 2016. The number of observational proposals submitted from around the world reached 1600, surpassing the Hubble Space Telescope. In June of every year, 150 leading astronomers from the various countries assemble and spend days cooped up in a hotel, holding meetings to examine these proposals and adopt about 400 of them. In Japan, more than half of the proposals were written by young researchers such as graduate students and post-docs.

Almost 1/4 of ALMA's observations are occupied with planetary system formation observations. When I was an undergraduate student, more than 35 years ago, I read a review paper of the “Kyoto Model.” I remember thinking, “It is a beautiful model. But to actually observe planets forming in the Universe, high resolution better than 1 arcsecond would be needed. I don’t think I’ll see planetary system formation observations within my lifetime.” Now, multiple ring structures, like those seen in the HL Tauri protoplanetary disk, are being discovered around one young star after another. I expect that by observing the disks of many young stars, we will be able to see the structural evolution of the protoplanetary disks generated as a result of planetary system formation.

Thanks to ALMA’s extremely high sensitivity, it detected the redshifted 88 μm wavelength emission line of ionized oxygen coming from a galaxy more than 13.1 billion light-years away discovered by the Subaru Telescope. This emission line is a good indicator of star formation activity. But because it is in the far infrared, it can’t be observed from the ground, so previously it had only been observed by using flying instruments. But when the redshift exceeds 3 (i.e. the distance exceeds 12 billion light-years) the observed wavelength of this emission line shifts to submillimeter waves, making it visible to ALMA. This is an excellent observational method to understand the details of star formation in the early Universe and the history of element production.

At the Subaru Telescope, the strategic program using the ultra-wide-field prime-focus camera (Hyper Suprime-Cam) is proceeding smoothly. This camera’s survey speed (= limiting magnitude x field of view area) is more than 10 times that of previous surveys. Equipped with this camera, the Subaru Telescope will without a doubt be on the world’s leading edge of observations until the U.S.A.’s Large Synoptic Survey Telescope starts operation in the mid-2020’s.

In February 2017, roughly 60 nights of data taken as part of this strategic program were made available in Public Data Release 1. The largest data set covers 108 square degrees on the sky. The data was taken in 9 colors. The limiting magnitude is 26.4 mag with the red filter. The stellar image size is 0.6 to 0.8 arcsecond. There is no comparable data set in the world. By the way the volume of the data set is equivalent to 10 million pictures taken with a normal digital camera. Ultimately, the survey will be 10 times this size, acquiring data across 1400 square degrees on the sky. Observations with Hyper Suprime-Cam will elucidate the distribution of dark matter across wide regions (and in terms of distance, about 90 % of the way out to the edge of the Universe). Hopefully we will be able to pursue the evolution of the large-scale structure of the Universe and get closer to understanding the true nature of dark matter and dark energy.

Regarding the open question of TMT, in FY 2016 the Hawai`i State Board of Land and Natural Resources held public hearings with area residents about reissuing the Maunakea Science Reserve Use Permit, resulting in a new permit being issued in September 2017. Thanks to continuing dialog between TMT International Observatory and the local residents, in Hilo Hawai`i the number of people supporting the construction of TMT is now higher than ever.

From the experience with the Subaru Telescope, the resistance in the Japanese astronomy community to building telescopes overseas disappeared. For ALMA it was a natural assumption that the telescopes would be arrayed overseas; the construction and operation also proceeded as an international project. For NAOJ, that was a new challenge. Fortunately, with the incorporation of NAOJ in 2004 the personnel system for academic faculty was reconsidered and the project system was established, changing the organizational structure to give it the flexibility needed for large international projects. It also became possible to have people with exceptional, specialized skills participate in large international projects as contract employees. Moreover by representing Japan in this kind of large international project, NAOJ’s duty as an inter-university research institute became better defined; this role has become making great contributions to strengthening research throughout all of Japan in the field of astronomy. Based on considerations like these, from here forward we would like to continue efforts towards realizing large-scale international collaboration projects.

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