Department of Electrical, Electronic and Computer Engineering

Key words Radio astronomy, Interferometry, VLBI, Satellite, Space Communication, Antenna, Data transmission, Data processing, Star formation, Galaxy

Doctor of Science / Professor

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Education

Kasukabe High School
The University of Tokyo, Faculty of Science, Department of Astronomy
Master's Course and Doctoral Program of The University of Tokyo, Graduate School of Science, Department of Astronomy

Professional Background

Japan Society for the Promotion of Science (Nobeyama Radio Observatory, NAOJ)
Institute of Space and Astronautical Science, Ministry of Education
Japan Aerospace Exploration Agency (JAXA, 2003-2024)
Director of Usuda Deep Space Center, JAXA (2016-2023)

Consultations, Lectures, and Collaborative Research Themes

Astronomy, Space Science, Ground station

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Main research themes and their characteristics

「Observation of interstellar molecules and cosmic dust in star forming regions with radio interferometry」

In the radio wave region with wavelengths from centimeters to millimeters, radio waves from regions called molecular clouds come from high-density regions with a hydrogen gas number density of 10^2-10^6 cm^{-3} (1 cm^{-3} in the normal universe). can be observed (Figure 1). It is thought that core of cosmic dust emission region will be accreted and be a stars. These molecular clouds were observed using a radio interferometer (array) that combined signals from multiple antennas at Nobeyama, NAOJ to increase the resolution of the image. We observed the distribution and dynamics of gas in this region, and studied how they are born. Reference [1], [2]

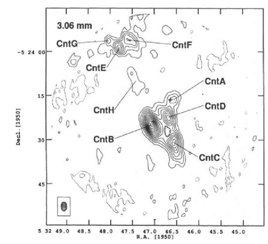

Figure 1 Radio emission at a wavelength of 3 mm from cosmic dust in the star-forming region Orion KL observed with the Nobeyama millimeter array.

「Forming a radio telescope larger than Earth... Developing a space VLBI system」

As one of the ultimate radio interferometer methods, we conducted Space VLBI, which combines a parabolic antenna on the ground and a parabolic antenna in space to create a extremely large radio interferometer (telescope). In order to realize this space VLBI, the Institute of Space and Astronautical Science (currently JAXA) launched the world's first space VLBI satellite, HALCA, in 1997, and conducted observations at wavelengths of 18 cm and 6 cm until 2003, producing many observational results. HALCA forms large radio telescope with antennas and radio interferometers in 14 countries around the world, and observed cosmic jets produced by black holes in many galaxies. Reference [3], [4]

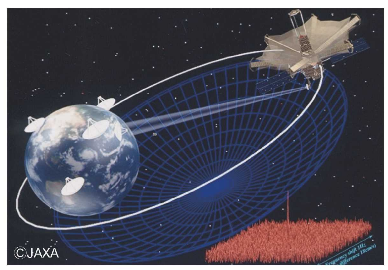

Figure 2 Image of Space VLBI system. The image on the lower right shows where radio waves from celestial bodies collected at the "focus" of the telescope in the correlator in sby each antenna are combined and focused.

「Development of a ground station for deep space missions」

In order to explore planets and asteroids in the solar system, spacecrafts must also take orbits around the sun as artificial planets, and take orbits outside the region around the Earth. The region that these probes navigate farther than 2 million kilometers from Earth is called "deep space." When communicating with these spacecrafts, a large parabolic antenna is needed to receive the weak signals from the spacecrafts, and to send commands to the spacecrafts. It is also necessary to emit high-power signal so that the signals can reach the spacecrafts. The 64m antenna at the Usuda Deep Space Center was completed in 1984 as an antenna for this purpose, and has supported many spacecrafts such as Hayabusa. However, nearly 40 years after its construction, a new deep space ground station was decided to be constructed. Construction began in 2015, and the deep space ground station with a diameter of 54 m was completed in 2021. I participated in the antenna construction from the design stage and was in charge of manufacture and measurement of the antenna system, and participate in the production of a Ka-band (32GHz) low-noise amplifier, which was developed in-house at JAXA. Reference [5]

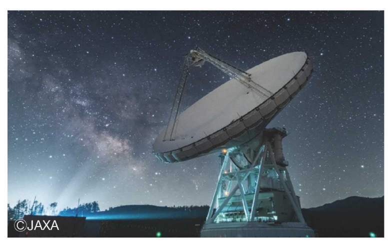

Figure 3 The 54m parabolic antenna of the Misasa Deep Space Ground Station of the JAXA Usuda Space Observatory, The construction is completed in 2021.

Major academic publications

[1] Murata, Yasuhiro, 1992, Astronomical Herald, 85, 434, Structure of the Orion molecular clouds.
[2] Murata, et al., 1992, PASJ, 44, 381, Aperture synthesis observation of small clumps in Orion-KL.
[3] Hirabayashi, H., Hirosawa, H., Kobayashi, H., Murata, Y., et al., 1998, Science, 281, 1825, Overview and Initial Results of the Very Long Baseline Interferometry Space Observatory Programme.
[4] Murata, Yasuhiro, 2005, Journal of Korean Astronomical Society, 38, 97, Space VLBI Project.
[5] Tsuboi, M.; Hasegawa, Y.; Tabuchi, G.; Murata, Y.;et al., 2023, PASJ, tmp..33T, Ka-band cryogenic low-noise receiver of the Misasa 54 m antenna for deep-space communications and radio astronomy.