

Activity Report of Commission J August 2015 to December 2015

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ALMA project

- Latest scientific topics from ALMA press release:

Nov 24, 2015 ALMA Links with Other Observatories to Create Earth-size Telescope

The Atacama Large Millimeter/submillimeter Array (ALMA) continues to expand its power and capabilities by linking with other millimeter-wavelength telescopes in Europe and North American in a series of very long baseline interferometry (VLBI) observations.

In VLBI, data from two or more telescopes are combined to form a single virtual telescope that spans the geographic distance between them. The most recent of these experiments with ALMA formed an Earth-size telescope with extraordinarily fine resolution.

These experiments are an essential step in including ALMA in the Event Horizon Telescope (EHT), a global network of millimeter-wavelength telescopes that will have the power to study the supermassive black hole at the center of the Milky Way in unprecedented detail.

Before ALMA could participate in VLBI observations, it first had to be upgraded adding a new capability known as a phased array. This new version of ALMA allows its 66 antennas to function as a single radio dish 85 meters in diameter, which then becomes one element in a much larger VLBI telescope.

The first test of ALMA's VLBI capabilities occurred on 13 January 2015, when ALMA successfully linked with the Atacama Pathfinder Experiment Telescope (APEX), which is about two kilometers from the center of the ALMA array.

On 30 March 2015, ALMA reached out much further by linking with the Institut de Radioastronomie Millimetrique's (IRAM) 30-meter radio telescope in the Sierra Nevada of southern Spain. Together they simultaneously observed the bright quasar 3C 273. Data from this observation were combined into a single observation with a resolution of 34 microarcseconds. This is equivalent to distinguish an object of less than ten centimeters on the Moon, seen from Earth.

The most recent VLBI observing run was performed on 1-3 August 2015 with six of the National Radio Astronomy Observatory's (NRAO) Very Long Baseline Array (VLBA) antennas. This combined instrument formed a virtual Earth-size telescope and observed the quasar 3C 454.3, which is one of the brightest radio beacons on the sky, despite lying at a distance of 7.8 billion light-years. These data were first processed at NRAO and MIT-Haystack in the United States and further post-processing analysis is being performed at the Max Planck Institute for Radio Astronomy (MPIfR) in Bonn, Germany.

The new observations are a further step towards global interferometric observations with

ALMA in the framework of the Global mm-VLBI Array and the Event Horizon Telescope, with ALMA as the largest and the most sensitive element. The addition of ALMA to millimeter VLBI will boost the imaging sensitivity and capabilities of the existing VLBI arrays by an order of magnitude.



(Credit: A. Angelich, NRAO/AUI/NSF)

Activities of meetings

- **Japan SKA Science Meeting on Cosmic Magnetism 2015**

Date: September 17 - 19, 2015

Venue: Kagoshima University

Although the origin of cosmic magnetism has not been revealed yet, magnetic field plays an important role in high energy phenomena such as stars, compact stars, galaxies, clusters of galaxies in various scales. Observation of the cosmic magnetic field is one of key science by the Square Kilometer Array (SKA) project, huge radio interferometry, in which construction is getting ready. One can expect that details of three-dimensional magnetic field structure are revealed by SKA. So we invite top researchers in this field from the world as well as a domestic researchers, and held a workshop to review the status of the research.

- **THz Astronomy in Antarctica**

Date: November 18 - 19, 2015

Venue: National Astronomical Observatory of Japan

Thanks to its excellent observational condition, the South Pole is paid much attention from all over the world as an observation base for radio to infrared astronomy. The Japanese antarctic astronomy consortium led by University of Tsukuba plans to construct a 10m THz telescope at antarctic inland area. A plan of 30m telescope which would be the next large plan to TMT is also considered. At this workshop, new science cases opened by THz observation at the South Pole would be discussed.

- **Workshop for ALMA Large Proposal of gAlactic Cold gAs (ALPACA) Survey**

Date: December 1-3, 2015

Venue: National Astronomical Observatory of Japan

Galaxies are multicomponent system mainly consisting of dark matter (DM), stars and interstellar medium (mainly cold gas). The evolution of DM and stellar component have been investigated by means of numerical simulations and large galaxy surveys at optical and near-infrared wavelengths. However, the evolution of the cold gas component (molecules/atoms) remains poorly explored. The redshift range of $z < \sim 2$ is the era in which the current Hubble sequence emerges, as well as the era for disk galaxies converting their cold gas to stars then developing their galactic disks. Further, one can expect larger and homogeneous data set of stellar/ionized gas/atomic gas of galaxies with the new-generation instruments such as HSC, PFS, and SKA. To understand the galaxy evolution at $z < \sim 2$, namely the second half of the cosmic history, it is important to investigate the molecular gas component statistically, since it links the information of other components (stellar/ionized gas/atomic gas) of galaxies.

We are now planning ALPACA survey (ALMA Large Proposal of gAlactic Cold gAs) aiming at investigating statistical properties (“amount”, such as cold gas mass function) and/or detailed “spatial distribution” and “kinematics” of molecular gas of galaxies at $z < \sim 2$. To design a desirable survey that can provide scientifically important and versatile data, we must list up the missing pieces for understanding the galaxy evolution, and discuss their importance. The workshop consists of invited review talks and contributed talks. Sufficient time will be spared for discussions. We are willing to discuss galaxy evolution regardless of the means (numerical simulations/semi-analytic models/observations at all wavelengths)!

- **13th Mizusawa VLBI observatory Users' Meeting**

Date: September 24 - 25, 2015

Venue: Mizusawa VLBI observatory of NAOJ

- **East Asian ALMA Science Workshop 2015**

Date: December 8 - 11, 2015

Venue: I-site Nanba in Osaka

The National Astronomical Observatory of Japan (NAOJ) and the Osaka Prefecture University are pleased to announce the annual “East Asian ALMA Science Workshop 2015”, to be held on December 8 - 11, at the I-site Nanba in Osaka Prefecture. This is the annual joint ALMA science workshop that involves all three East Asian ALMA partners (Japan, Taiwan and Korea). The main aim of this workshop is to continue to promote and stimulate international collaboration among the researchers in the EA partners, by reviewing and sharing the most recent ALMA science results from the first 4 years of ALMA operation. With the new observing modes such as long baselines and high frequencies available for cycle 3, now is a good time to review what has been achieved so far and discuss the future prospects for cycle 4 and beyond.

We plan to hold discussion sessions in order to have opportunities for closer communication among the researchers in related fields. In addition, we plan to have ample time for discussing “Large Proposals”, which is a new framework that is expected to start from cycle 4.

- **ALMA Workshop on Mass Accretion Mechanism at 1kpc to 1pc in the center of AGN**

Date: December 21 - 22, 2015

Venue: National Astronomical Observatory of Japan

- **ALMA workshop: "ALMA deep surveys on GOODS-S and beyond"**

Date: December 15 - 16, 2015

Venue: Institute of Astronomy, The University of Tokyo

- **B mode from Space**

Part 1: The Science goals, status of spaceborne projects, foregrounds

Part 2: Mission design, technologies and challenges for the spaceborne observations

Dates: December 10 - 16, 2015

Venue: Lecture Hall, Kavli IPMU main building

The goal of the workshop is to discuss the science goals, status of CMB polarization projects, foregrounds and mission design, technologies and challenges for the spaceborne observations of CMB polarization to detect primordial gravitational waves and thus to prove the inflation theory. The workshop will be the first meeting where the LiteBIRD mission is focused on.