Activity Report of Commission J
March 2014 to July 2014

August 6, 2014

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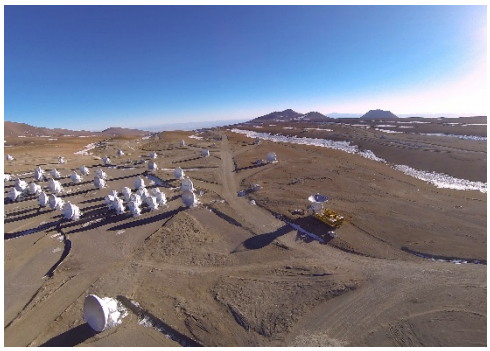
ALMA project

- *Jun 16, 2014 Final ALMA Antenna Arrives on the Chajnantor Plateau*

The final antenna for the Atacama Large Millimeter/submillimeter Array (ALMA) project has been taken up to the high-level site at the ALMA Observatory, 5.000 meters above sea level. Its arrival completes the complement of 66 ALMA antennas on the Chajnantor Plateau in the Atacama Desert of northern Chile --- where they will in future work together as one giant telescope.



- Latest scientific topics:

1. *Jul 03, 2014 Dynamical Star-Forming Gas Interaction Witnessed by ALMA*

Dynamical interaction of star-forming gas was found in a star-forming region by observations with the Atacama Large Millimeter/submillimeter Array (ALMA). This is a remarkable observation result that disproves a conventional assumption that sun-like stars are formed by slow contraction of gas clouds.

A research team led by Kazuki Tokuda and Toshikazu Onishi at Osaka Prefecture University conducted ALMA observations of a high-density gas cloud called MC27/L1521F in the constellation Taurus. From past observation results, it was confirmed that MC27 hosts a new-born star. And by this observation the research team found a new starless high-density core, which is considered to be very close to the initial stage of star formation, right next to the new-born star. Also, the research team detected an arc-shaped gas cloud around MC27 which is assumed to be formed by dynamic gravitational interaction of two or more gas cores. Such dynamical kinematics of star formation which was newly found by this observation will be a key factor in understanding star formation process starting from gas clouds.

These observation results were published in The Astrophysical Journal Letters (June 11, 2014) as Tokuda et al. "ALMA Observations of a High-density Core in Taurus: Dynamical Gas Interaction at the Possible Site of a Multiple Star Formation".

2. *Jun 12, 2014 Gigantic Explosion Buried in Dust: ALMA Probes Environment around Gamma Ray Bursts*

For the first time, a group of Japanese researchers detected radio emission from

molecular gas in galaxies hosting gamma ray bursts (GRBs), the brightest explosive phenomenon in the universe, with the Atacama Large Millimeter/submillimeter Array (ALMA). Also, this observation revealed that the observed GRBs occurred in a remarkably dust-rich environment with little molecular gas.

The research group led by Bunyo Hatsukade, an assistant professor at the Chile Observatory of the National Astronomical Observatory of Japan (NAOJ), conducted observations of two galaxies hosting GRB 020819B and GRB 051022 whose distance from us is about 4.3 billion and 6.9 billion light years, respectively. Detection of radio emission from GRB host galaxies, which had been a long-sought goal for astronomers, was finally made possible by ALMA with its unprecedentedly high sensitivity.

On top of this, ALMA's unparalleled high resolution (eyesight) also revealed that the GRB 020819B host is very different in its spatial distribution of molecular gas and dust; molecular gas is distributed at the nuclear region while dust is concentrated at the GRB explosion site. The ratio of dust to molecular gas at the GRB site is ten or more times higher than other normal environments. It is the first time that the spatial distribution of molecular gas and dust in the GRB host galaxies was verified by observations.

These findings will be published in Nature (June 12, 2014) as an article titled "Two γ-ray bursts from dusty regions with little molecular gas" Hatsukade et al.

Activities of meetings

- **32th NRO Users Meeting**

  Date: 23-24 July, 2014

  Place: Nobeyama Radio Observatory, NAOJ

  Overview: The full ALMA age has opened and cutting-edge science results are obtained one after another. In order to use ALMA efficiently, the importance of having original data is increasing very much. Preparing for the ALMA age, advancements and improvements of the observing system for 45-m radio telescope so as to be an international competitive equipment have been made. In the user's meeting of this year, it is discussed that how Nobeyama would be used in Japan with the limited resources.

- **ASTE/ALMA Development Workshop 2014**

  Date: July 24, 2014

  Place: National Astronomical Observatory of Japan, Mitaka

  ASTE (Atacama Submillimeter Telescope Experiment) is a submillimeter telescope of 10 meter diameter, which was constructed by NAOJ at an altitude of 4860 meters next to the ALMA site. The ASTE telescope started its observation from 2003 as the first full-fledged

submillimeter telescope in the Southern Hemisphere, and has implemented various experiments/developments and demonstrated significant results as a precursor telescope to ALMA. In this workshop, participants discussed mainly the future enhancements of ASTE and future development program of ALMA which has just started its full operations.

In the presentations given by the participants, a variety of new development plans were proposed such a terahertz receiver that enables observations at a frequency higher than the Band 10 receiver covering the highest frequency band of ALMA, a radio camera and multi-beam receiver to achieve wider-field observation, 3-dimensional spectrometer aiming to effectively determine the distance to a distant galaxy (redshift), and a software correlator that allows high-accuracy observation. These developments also served as basic development to realize wider-field of view of ALMA. Furthermore, researchers involved in the study of star formation, the Milky Way Galaxy, Magellanic Cloud, and the distant universe suggested new ideas of observation instruments to promote the research of these areas.

Since the ASTE telescope has an aspect of "experiment" as its official name suggests, it can be used for on-site experiments of newly developed equipment for the improvement of ALMA. Based on the discussions at this workshop, the development of new observation instruments will be brought forward into a concrete shape.

- **East Asia ALMA Science Workshop 2014**

  Date: July 14-17, 2014

  Place: Phoenix Island in Jeju, Korea

  The "East-Asian ALMA Science workshop 2014" will be held in Phoenix island, Jeju island, Korea, on July 14th - 17th, 2014, hosted by the ALMA Korea project group in the Korea Astronomy and Space Science Institute (KASI). The LOC is pleased to host this annual joint ALMA science workshop of Japan, Taiwan, and Korea, especially, in the year when the ALMA Korea project has officially started in the KASI.

  The main aim of this annual workshop is to continue promoting collaborations among the East Asian astronomers for ALMA sciences. Therefore, we will prepare ample time for group discussions, as well as reporting the ALMA current status, science results, and proposals. In addition, we will have a session for ALMA archive sciences in the afternoon of July 14th, 2014. Since most of Cycle 0 data were already archived, it is good time to think about ALMA archive sciences. Please join this session, hear science cases using archive data and learn how to navigate and collect observational data from a ALMA archive. Except of the archive session, most of time of July 14th will be devoted to a CASA (Common Astronomy Software Applications) tutorial. If you want to learn the CASA, please also join this tutorial session, too.

- **13rd IVS Technology Development Center Symposium**

  Date: June 4, 2014

  Place: National Institute of Information and Communications Technology, Kashima Space

Technology Center

Developments of antenna and observation system based on the VGOS specification of the next-generation broadband geodetic VLBI system promoted by IVS is advanced in each country now (the U.S., Germany, Spain, Japan, Russia, etc.). In NICT, development of the broadband VLBI system (Gala-V) based on VGOS has been made. The wideband receiving system which can observe 6.4 to 15 GHz was installed in Kashima 34-m radio telescope in the last December, and it has succeeded in the simultaneous observation of methanol maser lines at 6.7GHz and 12.2 GHz. In the Geographical Survey Institute, an antenna with new VGOS specification is installed in Ishioka, Ibaraki, and observation is planned from this year. The scope of this symposium is from the development of such a new observation system, a new technical development concept and a geodetic survey, astronomical researches, GNSS technology, and space geodesy technical based on VLBI and related techniques.

- **Workshop on the Galactic Center 2014 – traces left outside the Galactic Plane -**

  Date: 9 May, 2014

  Venue: Nagoya University

  The Galactic center is the most complicated region in our galaxy. Although many of observational researches have been made, discussions/interpretations were usually based on each wavelength and no consensus on the interpretation of this region has been achieved. In this workshop, the results obtained from observations of each wavelength, such as radio, infrared, X-rays, etc. in recent years, are presented for information exchange and discussions with theoretical point of view. Particularly, inflow and outflow of the galactic center and its influence will be focused on.