

## ATACAMA LARGE MILLIMETER ARRAY

### ALMA Project Progress

The fifth anniversary of the February 23, 2003 signing of the Agreement concerning the Joint Construction and Operation of the Atacama Large Millimeter Array (ALMA) saw the project entering the last year before commissioning observations will commence. In December, the U. S. Congress enacted the FY2008 budget, which provided funding for the seventh year of ALMA construction at the level requested by the National Science Foundation. In early February, the President requested funding for FY2009, the eighth year of this eleven year project. In preparation for deployment of the first stations of the array next year, the infrastructure at the mid-level and high altitude sites has reached a mature state and components of the array continue to stream to the ALMA sites around the world. The Proceedings of the November 2006 ALMA Conference in Madrid, *Science with the Atacama Large Millimeter Array: A New Era for Astrophysics*, has been published by Astrophysics and Space Science as Volume 313, Numbers 1–3, dated January 2008. This volume gives a wide-ranging overview of the types of science ALMA will produce.

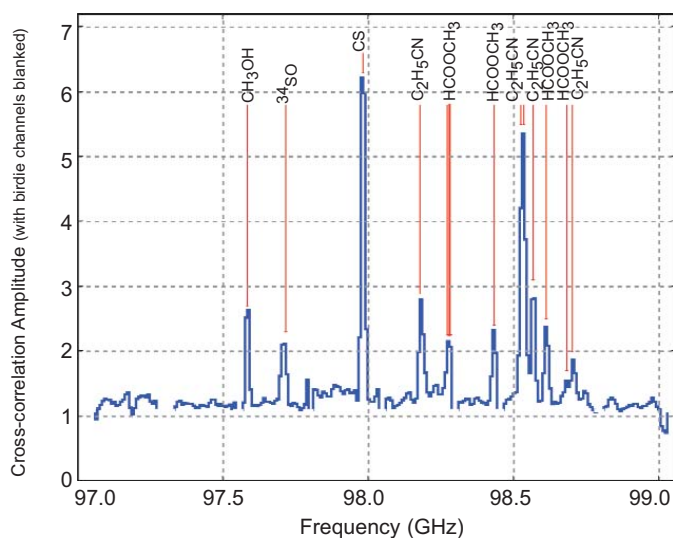


Figure 1. The first spectrum obtained with the ALMA prototype antennas at the ALMA Test Facility used the evaluation receivers and production backend equipment. Blanked channels represent missing data.



Figure 2. The huge ALMA antenna transporters, foreground, arrived at the Operations Support Facility, background, on February 14, 2008.

Software and hardware components of ALMA have been under test at the ALMA Test Facility (ATF) in New Mexico. As these tests reach maturity this site will close and final testing of production components will occur at the Operations Support Facility near San Pedro de Atacama in Chile. Highlights of the recent testing in New Mexico have included continued routine interferometry. A recently installed scaled down version of the main correlator was installed last year; in January this produced its first interferometric spectrum, shown in Figure 1, taken in the lowest resolution mode of the correlator. Single antenna spectra of the SiO maser line at 86 GHz were also obtained, to test spectral line pointing of individual antennas.

Production equipment continues to arrive at the ALMA sites. The correlator for the Atacama Compact Array was installed in the Array Operations Site Technical Building (AOS TB) at 5000m elevation by personnel from the National Astronomical Observatory of Japan late in 2007. Excavation for the antenna stations has begun near the AOS TB. At the 2900m altitude of the Operations Support Facility, the Technical Building (OSF TB) complex construction was completed (left of Figure 2). The third VertexRSI antenna was delivered and assembled in the Site Erection Facility (SEF, right,



Figure 3. Construction on the OSF technical facility complex has been completed. The antenna assembly building (left) and technical building (right) are shown here.

Figure 2) while acceptance testing of the first of these antennas began (this antenna is situated to the left of the SEF in Figure 2). The fourth VertexRSI antenna is en route to Chile as this is being written.

Adjacent to this facility lies the Mitsubishi antenna erection area, to which the fourth and final Mitsubishi 12m antenna was delivered at year's end. Acceptance tests of the first of these antennas are well along. At the close of 2007, seven ALMA telescopes have been delivered to Chile, about one tenth of the total. As they are accepted, antennas will be moved to the grounds of the OSF TB where they will be outfitted with produc-



Figure 4. The antenna transporters travel through the Cordillera del Sal toward San Pedro de Atacama, lying just beyond, and the ALMA operations site, to the right of this image on the flanks of the Andes. Licancabur is to the right.



Figure 5. The pedestal for Vertex Antenna No. 3 and the backup structure have now been mated. VertexRSI antenna No 2, fully assembled, is in the Site Erection Facility.

tion equipment, including the receiver packages, and tested in a continuation of the activities currently under way at the ATF. The antennas will be moved by one of the two transporters, capable of lifting antennas weighing 115 tons and placing them on foundations with a precision of millimeters. Both of these machines, weighing 130 tons each, embarked from the Scheuerle Fahrzeugfabrik GMBH factory and embarked on their journey to port at Heilbronn, Germany.

These behemoths, named Otto and Loge at a ceremony last October, travel on 28 tires and extend 30 feet in width and 60 feet long; they are 18 feet high. They were transferred to a barge to continue the journey down the Neckar River past Heidelberg to the Rhine, then down the Rhine to Antwerp, Belgium. By December 11, they had arrived in Antwerp, where they were transferred to an ocean vessel that arrived in port at Mejillones, Chile on February 7. On February 14, 2008 they completed their journey to the ALMA operations base camp at 9600 ft elevation, where they were within sight of their intended cargo, the seven antennas now at the OSF, for the first time. After a few months of testing, they will move the first antenna accepted to an antenna foundation at the just-finished OSF TB for early antenna testing. Eventually these two well-traveled giants will move the antennas to the 16400 foot

level at which ALMA observes, each powered by two 500 kW diesel engines.

“When completed in 2012, ALMA will be the largest and most capable imaging array of telescopes in the world,” said Massimo Tarengi, the ALMA Director. “The ALMA antenna transporters, which are unique technological jewels, beautifully illustrate how we are actively progressing towards this goal.”

Professor Thijs de Graauw (SRON and Leiden University, Netherlands) has agreed to accept the position of ALMA Interim Director, effective 1 April 2008. The search for a new Director is ongoing and vacancy notices have been posted on the websites of the ALMA

Executives. In early February Dr. A. J. Beasley, ALMA Project Manager, announced his decision to resign effective in late June to attend to family responsibilities. Dr. Richard Prestage, currently Assistant Director for Green Bank Operations at NRAO, announced that in May he will join the Joint ALMA Observatory as Head of Technical Services. He will join Dr. Lars-Ake Nyman, Head of Science Operations and Russell Smeback, Head of Administration, in the Santiago offices. Also moving to Santiago will be Dr. Pere Planesas, currently at OAN, Madrid, and Dr. R. Sramek, of NRAO, who are members of the Assembly, Integration and Verification (AIV) science team.

*Al Wootten*

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### North American ALMA Science Center

As ALMA moves steadily towards its operational phase, things are getting busier in the North American ALMA Science Center (NAASC). We are supporting a limited beta release of the CASA software, helping staff the ALMA Test Facility in Socorro, testing the major ALMA user software systems, and preparing for participation in Commissioning and Science Verification (CSV) in Chile early next year. To support these commitments, we expect to hire three Assistant Scientists into the NAASC, two for CSV-liaison and one for CASA development and support. We are also recruiting an ALMA EPO Program Officer to prepare a public outreach program commensurate with ALMA's broad appeal and scientific promise. See: [http://www.nrao.edu/administration/personnel\\_office/careers.shtml](http://www.nrao.edu/administration/personnel_office/careers.shtml). In the coming year, ALMA Chilean Operations will also be hiring a significant number of operations staff, including several astronomers. See: <http://www.alma.cl/jobops/>.

We are preparing for the science use of ALMA, both in our web presence and in tools. To this end, the NAASC staff is working with NRAO EPO on our science-based web interface. NAASC staff also visited the Space Telescope Science Institute for an overview and discussion of their science user support activities. Similar input was received from the Spitzer Science Center Observer Support Team. The lessons learned from

these preeminent science user facilities will guide us as we work towards our user support implementation plans. Concerning user tools, the NAASC supported on-line spectral line database “*Splatalog*” had its beta release earlier this year, as described in an accompanying article. And the NAASC staff continues to be involved in extensive testing and training for the CASA data reduction package (<http://casa.nrao.edu>). The initial deployment of the first Beta CASA release to members of several ALMA science advisory committees including the ALMA North American Science Advisory Committee (ANASAC), as well as the inauguration of our CASA helpdesk system over the last few months has been successful. The feedback we have received from this process has been very useful in refining our development plans. We expect to offer CASA tutorials at the upcoming Eleventh Synthesis Imaging Summer School and to make the package available as a Beta release to the astronomical community this summer.

The NA ARC (a subset of the NAASC) hosted the international Science Operations IPT meeting in Charlottesville from February 26–27. This meeting brings together staff from the ALMA Regional Centers in East Asia, Europe and North America, and the Joint ALMA Observatory in Chile, with the goal of

coordinating and prioritizing work towards successful ALMA operations. Work concentrated on developing the Operations implementation plans, and ALMA-wide hiring. This was the last meeting of the group lead by outgoing JAO Director Massimo Tarengi. This group has been instrumental in developing the ALMA Operations Plan, which was successfully presented to an international review committee exactly a year ago to the day. Our grueling day-long meetings were followed by pleasant evenings celebrating what has proven to be a most productive and enjoyable international collaboration.

The NAASC AD's office is preparing material on ALMA operations for the on-going AUI operations review, as well as for the up-coming Visiting and Users Committee meetings. We have also sent the revised version of the MOU with Canada on ALMA operations to HIA for final comment.

We are in the process of organizing the 3rd annual NAASC science workshop in collaboration with the ANASAC. This year's workshop will be on the topic of 'Massive Star Formation Within and Beyond the Galaxy' and it will be held in Charlottesville September 25–27, 2008. Please see the accompanying Newsletter article for more details. The ANASAC is also considering scientific input into the ALMA development plan.

Finally, NAASC staff have visited a number of institutions and presented summaries of ALMA science and status. If your institution is interested in having an NRAO staff member visit and discuss ALMA, please contact ccarilli@nrao.edu.

*Chris Carilli*

### The ALMA Spectral Line Catalog

The "beta" release of the Database for Astronomical Spectroscopy: *Splatalogue* occurred on February 1 and is available at <http://www.splatalogue.net>. The release was made available to the entire astronomical community but with an emphasis on those researchers familiar with the public catalogs available for molecular spectroscopy including the Cologne and JPL Databases,

and the Lovas list of detected astronomical transitions. The main purposes of the release were to:

- 1) illustrate the power of the search capabilities of the database over all available line catalogs;
- 2) introduce a new catalog to the community, the Spectral Line Atlas of Interstellar Molecules (SLAIM) which will only be available through Splatalogue;
- 3) provide the community with a complete list of frequencies of H, He and C recombination lines;
- 4) add newly detected transitions to the Lovas list of detected astronomical transitions and
- 5) provide a limited sample of species (~200 out of 650) where the quantum numbers between all 4 catalogs were resolved, provide the line strength and energy levels in all useful astronomical units, and provide the community with an NRAO recommended rest frequency for a molecular transition.

Feedback on these goals have been sent to the ALMA Working Group on Spectral Line Frequencies and updates and corrections are ongoing. Splatalogue was also presented at the 211th AAS meeting in Austin, TX.

We anticipate a "Beta 2" release in June 2008 which will continue the work already started on the resolution and reconciliation of quantum numbers and species between all four catalogs. In the "Beta 2" release, all species will have consistent quantum numbers and the line strengths and energy levels will be available in all useful astronomical units for each transition. In addition, the default search criteria for Splatalogue will be only on NRAO recommended rest frequencies. There will also be additional search criteria and filters available, flexibility in exporting the data from a selected search, template spectra of selected astronomical environments including hot molecular cores and protoplanetary nebulae from cm to mm wavelengths, and a limited functionality to generate synthetic spectra based on the physical conditions of the astronomical environment and the type of telescope used to make the observation, including but not limited to ALMA and the EVLA. Future plans include presenting

*Splatalogue* at the 63rd OSU meeting on Molecular Spectroscopy in June 2008 and the creation of *my.splatalogue.net* where researchers can save and recall their most used and searched on criteria. Any

questions on the form, functionality and use of *Splatalogue*, please contact Anthony Remijan at [aremijan@nrao.edu](mailto:aremijan@nrao.edu) or Andrew Markwick-Kemper at [andrewjmk@gmail.com](mailto:andrewjmk@gmail.com).

Anthony Remijan

## **The Birth and Feedback of Massive Stars, Within and Beyond the Galaxy: The NAASC Science Workshop for 2008**

The North American ALMA Science Center will host its third annual science workshop in Charlottesville from September 25–27, 2008. The subject of this year's workshop is *The Birth and Feedback of Massive Stars, Within and Beyond the Galaxy*—a timely theme, given the ability of ALMA's frequency coverage, sensitivity, and resolution to bridge the gap between Galactic and low-redshift extragalactic studies of star formation and feedback. Key science questions for the workshop include:


- What molecular cloud properties influence massive star formation?
- What are the best observational discriminators between theories of massive star/cluster formation?
- How do forming massive stars affect their parent molecular clouds (e.g., turbulence, triggering)?
- How does massive star formation differ in the most extreme environments (e.g., Galactic center, super star clusters, starburst galaxies)?
- What physics determines star formation scaling relations in galaxies?

More details about the program and logistics can be found at the workshop website: <http://www.cv.nrao.edu/php/meetings/massive08/>. The organizers encourage students, postdocs, and senior scientists working on relevant theoretical and (at all wavelengths) observational projects to preregister and submit abstracts before the deadline of May 1. A majority of the program will be selected from contributed abstracts, with a particular focus on the “wish

TRANSFORMATIONAL SCIENCE WITH ALMA:

## The Birth and Feedback of Massive Stars, Within and Beyond the Galaxy

Sept. 25-27, 2008 at the North American ALMA Science Center of the  
National Radio Astronomy Observatory in Charlottesville, VA







**Key Science Questions:**

- What physics determines star formation scaling relations in galaxies?
- What molecular cloud properties influence massive star formation?
- What are optimal probes of the physical conditions in massive star forming regions?
- How does massive star formation differ in the most extreme environments (Galactic center, super star clusters, starburst galaxies)?
- What are the best observational discriminators between theories of massive star/cluster formation?
- How do forming massive stars affect their parent molecular clouds (e.g. turbulence, triggering)?
- What effects do young massive clusters have on their parent galaxies (e.g. galactic winds, triggering)?
- How can ALMA best address these questions?

**SOIC:**  
A. Baker (Ruigors; co-chair)  
J. Bally (U. Colorado)  
C. Brogan (NRAO)  
T. Heckman (Johns Hopkins)  
R. Indebetouw (NRAO/UVa; co-chair)  
K. Johnson (UVa)  
D. Johnstone (HEA)  
J. Jan (U. Florida)  
L. Testi (ESO)  
J. Turner (UCLA)  
K. Wada (NAOJ)  
J. Williams (U. Hawaii)  
C. Wilson (McMaster)  
A. Wootten (NRAO)

**LOC:**  
C. Brogan (NRAO)  
L. Clark (NRAO; chair)  
A. Hildes (NRAO)  
J. Hubband (NRAO)  
T. Hunter (NRAO)  
R. Indebetouw (NRAO/UVa)  
R. Neighbours (NRAO)  
A. Reines (UVa)  
A. Remijan (NRAO)



http://www.cv.nrao.edu/naasc/massive08

list” of topics that have been prioritized by the organizers and listed on the website under “meeting philosophy”. We look forward to seeing you in Charlottesville this fall!

A. Baker and R. Indebetouw