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ALMA Opens Its Eyes

The most powerful millimeter/submillimeter-wavelength telescope in the world opens for business.

Humanity's most complex ground-based astronomy observatory, the Atacama Large Millimeter/submillimeter Array (ALMA), has officially opened for astronomers at its 16,500-foot high desert plateau in northern Chile. Thousands of scientists from around the world competed to be the first few researchers to explore some of the darkest, coldest, farthest, and most hidden secrets of the Cosmos with this new astronomical tool.

"*We went to one of the most extreme locations on Earth to build the world's largest array of millimeter/sub-millimeter telescopes having a level of technical sophistication that was merely a dream only a decade ago,*" said Dr. Mark McKinnon, North American ALMA Project Manager at the National Radio Astronomy Observatory (NRAO) in Charlottesville, Virginia. "*And, now, here we are at the start of ALMA Early Science. We made the impossible possible. This truly is a great occasion!*"

For the start of Early Science, around one third of ALMA's eventual 66 radio telescopes will make up the growing array, with two-thirds of those delivered by NRAO. Even while still under construction, ALMA has become the best telescope of its kind -- a fact that was apparently well known to the astronomers who requested to observe with it.

Considering the limited number of hours allocated to this first phase of science, ALMA could only take about a hundred projects. "*It was absolutely tremendous to receive more than nine hundred project proposals from astronomers from throughout the world wanting to use ALMA in this first ever science period!*" said Dr. Lewis Ball, ALMA Deputy Director and NRAO's ALMA Chief of Staff. "*That*

represents a level of demand which is unprecedented across any ground-based or space telescope." The successful projects were chosen based on their scientific value, their regional diversity, and also their relevance to ALMA's major science goals.

"The 'M' in ALMA stands for 'millimeter/submillimeter' waves, because ALMA views the Universe in these long wavelengths of light, much longer than the optical light we see with our eyes," said Dr. Alison Peck, an NRAO astronomer serving as ALMA Deputy Project Scientist during construction. *"With millimeter and submillimeter waves, we can watch planet formation, investigate astrochemistry, and detect the light that is finally reaching us from the Universe's earliest galaxies. ALMA's first projects will flex the telescope's capabilities in all of these fields and many, many more."*

One of the projects chosen for ALMA Early Science observations was that of Dr. David Wilner of the Harvard-Smithsonian Center for Astrophysics in Cambridge, Massachusetts. Wilner said, "*My team hunts for the building blocks of solar systems, and ALMA is uniquely equipped to spot them*."

His team's target is AU Microscopii, a star 33 light years away that is only 1% of the age of our Sun. *"We will use ALMA to image the 'birth ring' of planetesimals that we believe orbits this young star. Only with ALMA can we hope to discover clumps in these dusty asteroid belts, which can be the markers of unseen planets."* Wilner and his team will share their data with a European team who also requested ALMA observations of this nearby, dust-ringed star.

Dr. Simon Casassus, from the University of Chile, and his team will use ALMA to observe the gas and dust disk around HD142527, a young star that is 400 light years away. *"The dusty disk around this star has a very large gap, which may have been carved by the formation of giant planets,"* said Casassus.

"Outside the gap, this disk contains enough gas to make about a dozen Jupiter-sized planets. Inside the gap, a young gaseous giant planet could still be forming, if there is gaseous material available." Their ALMA observations will measure the mass and physical conditions of gas interior to the gap. *"Thus, ALMA gives us a chance to observe planet formation, or its most recent wake,"* said Casassus.

Farther away, 26,000 light years from us in the center of our Galaxy, sits Sagittarius A*, a supermassive black hole four million times the mass of our Sun. Gas and dust between it and us hide it from our optical telescopes. However, ALMA is tuned to see through the galactic murk and give us tantalizing views of Sgr A*.

Professor Heino Falcke, an astronomer at Radboud University Nijmegen in the Netherlands**,** said, "*ALMA will let us watch flares of light coming from around this supermassive black hole, and make images of the gas clouds caught by its immense pull. This will let us study this monster's messy feeding habits. We think that some of the gas may be escaping its grip, at close to the speed of light*."

Like the black outlines in a child's coloring book, cosmic dust and cold gas trace out structures inside galaxies, even if we can't see those galaxies clearly. At the outer fringes of our visible Universe lie the mysterious starburst galaxies, bright islands in an otherwise calm, dark Cosmos. ALMA will hunt for cold gas and dust tracers here, as far back as a few hundred million years after the Big Bang, at a time astronomers call "cosmic dawn."

Dr. Masami Ouchi of the University of Tokyo in Japan will use ALMA to observe Himiko, a very distant galaxy churning out at least 100 Suns' worth of stars every year and surrounded by a giant, bright nebula. *"Other telescopes cannot show us why Himiko is so bright and how it has developed such a huge, hot nebula when the ancient Universe all around it is so calm and dark,"* said Ouchi. *"ALMA can show us the cold gas deep in Himiko's star-forming nebula, tracing the movements and activities inside, and we will finally see how galaxies started forming at the cosmic dawn."*

During its Early Science observations, ALMA will continue its construction phase in the Chilean Andes, high on the remote Chajnantor Plain in the harsh Atacama Desert. Each new, climate-armored telescope will join the array and be linked via fiber optic cabling. The views from each distant telescope are assembled into one large view by one of the world's fastest, special-purpose supercomputers, the ALMA Correlator. Designed and built by the NRAO Technology Center in Charlottesville, Virginia, the ALMA Correlator performs 17 quadrillion operations per second.

By 2013, ALMA will be an up to 11-mile wide array of 66 ultra-precision millimeter/submillimeter wave radio telescopes working together as one and built by ALMA's multinational partners in North America, East Asia, and Europe.

"With the start of Early Science, we welcome ALMA into NRAO's working suite of state-of-the-art engines of exploration alongside the Very Large Array, the Very Long Baseline Array, and the Green Bank Telescope," said Dr. Fred K. Lo, NRAO Director. *"With them, and other novel facilities around the world, the astronomical community is entering a golden age of discovery using radio techniques."*

The National Radio Astronomy Observatory is a facility of the National Science Foundation, operated by Associated Universities, Inc.

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