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PENONOMÉ, Panama – Panamanian President Ricardo Martinelli recently inaugurated the first wind turbine at the Parque Eólico Penonomé. The complex is expected to provide up to 7% of the country's electricity in the next two years. (Rodrigo Arangua/AFP)

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Chile: ALMA looks for answers in the universe

The Atacama Large Millimeter/sub-millimeter Array (ALMA) radio telescope helps astronomers explore the universe.

By Carolina Contreras for Infosurhoy.com - 08/08/2013

Thanks to the ALMA radio telescope in northern Chile, European scientists discovered a "dust trap" around the Oph-IRS 48 system, about 390 million light-years away. The discovery can provide information on the formation of planets from dust accumulation. (Courtesy of ALMA)

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LLANO DE

CHAJNANTOR, Chile – What's the universe's origin? How did planets and stars form? Is there life beyond Earth?

Scientists from throughout the world hope the Atacama Large Millimeter/sub-millimeter Array (ALMA) – the world's largest radio telescope – in Chile will provide answers.

They work at Llano de Chajnantor, which means "Place of Departure" in the Kunza language. It is 5,000 meters above sea level in the region of Antofagasta 1,657 kilometers north of Santiago.

But most importantly, it is home to the majority of ALMA's antennas, which scientists use to scrutinize the universe.

The difference between ALMA and an optical telescope is in the electromagnetic waves that are capable of being observed. While the latter captures objects in light visible to the eye, a radio telescope like ALMA picks up radio waves emitted by different bodies in the universe that cannot be seen with the naked eye.

The 66 ALMA antennas will examine the beginnings of the universe 13 billion light-years away, through millimeter and sub-millimeter waves impossible to observe with optical telescopes, according to Pierre Cox, ALMA's director.

"This is a mammoth task and at the same time, an achievement of humanity that will give us unforeseen rewards," Cox, a French astronomer, said. "With the array of antennas and its current configuration and technology, it is by far the largest observatory ever built."

Fifty-eight of the 66 antennas are operational on the Llano de Chajnantor plateau, forming a massive radio telescope that is 16 kilometers in diameter. The remaining eight antennas are expected to be operational by the end of 2013.

The existing antennas use a technique known as interferometry, in which images from various sources form a single, detailed image.

"The resolution capability of an interferometer doesn't depend on the diameter of each antenna but on the maximum spacing between them," said Ignacio Toledo, a Chilean astronomer who works as a data analyst at ALMA. "By increasing the space between the antennas, their resolution capacity increases."

(http://www.infosurhoy.com/cocoon/saii/images/2013/08/08/photo2A.jpg)

ALMA Director Pierre Cox: "I think that with its array of antennas and current configuration and technology, this is by far the largest observatory ever built on Earth." (Courtesy of ALMA)

The waves picked up by antennas are processed in a supercomputer called a correlator, which was specially designed for the observatory with a per-second capacity comparable to three million common computers.

Astronomers study the data at Llano de Chajnantor's base camp before disseminating it throughout the scientific community for further analysis.

In 2014, all of the information will be compiled into a virtual library that can be accessed by scientists throughout the world.

ALMA has revolutionized space study. When all of the antennas are working in sync by the end of 2013, ALMA will be capable of recording details at a resolution 10 times greater than the Hubble Space Telescope.

"This was impossible to do before ALMA," said Chilean astronomer María Teresa Ruiz, who is part of a project at ALMA that studies brown dwarfs, which have the same composition of other stars but not enough mass to shine. "All phenomena occurring in the universe – yet not in visual light – were hidden to science. Now, we will be able to see and study them."

For example, the question of how the planets were formed could be on the verge of being answered after European astronomers at ALMA discovered in June a "dust trap" surrounding the Oph-IRS 48 star system about 390 million light-years away.

"These kinds of traps could actually be the birthplace of newborn planets," Nienke Van der Marel, a Dutch astronomer in charge of the project, told reporters.

Chile, an ideal place for space observation

ALMA began to take shape in 1999. Two years later, an alliance among the European Organization for Astronomical Research in the Southern Hemisphere (ESO), the U.S. Science Foundation (NSF), the National Research Council of Canada (NRC), the National Science Council of Taiwan (NSC), the National Institutes of Natural Sciences (NINS) in Japan, and Academia Sinica in Taiwan (AS) was signed to build the telescope.

ALMA's astronomical complex took 10 years to be built at a cost of US$1.4 billion, which was funded by partner nations. It was inaugurated in March.

Chile was selected as the site because the country's minimum presence of water vapor in the Andean Plateau, or Altiplano, facilitates the atmospheric transparency needed for the antennas to pick up millimeter wavelengths with almost no interference or distortion.

(http://www.infosurhoy.com/cocoon/saii/images/2013/08/08/photo2B.jpg)

Ignacio Toledo, a Chilean astronomer who has worked as a data analyst at ALMA since 2011: "The information that ALMA antennas pick up every day surprises us." (Gustavo Ortiz for Infosurhoy.com)

"[With ALMA], 60% of the human capacity to observe the universe will be concentrated in Chile, virtually making the country the astronomical capital of the world," Chilean President Sebastián Piñera said during the inauguration ceremony, referring to the 13 major scientific observatories operating in the Andean nation.

A Tower of Babel

Eight of the 46 astronomers who work at ALMA's base camp are Chilean.

"[ALMA] is an observatory unlike any other," said Lizette Guzmán, a Mexican astronomer who arrived at the observatory in April to work for ESO. "It is a complex project that allows us to analyze stellar objects at different frequencies to better understand them. It is very inspiring to see how each person does their job to make this project work and deliver the results that we have already begun to see."

ALMA's observation projects are approved by an international commission, which evaluates proposals from astronomers throughout the world.

As the host country, Chile has allocated 10% of the annual observation time for projects selected by the commission.

The majority of the observation work at ALMA is remote, as astronomers receive information for their research projects via the Internet.

Professionals from at least 20 nationalities, including Belgians, Germans, French, Japanese, Spaniards and U.S. nationals live in a small city called ALMA, about 30 kilometers from the antennas. The scientists have not been hindered by the diversity of languages.

"It has also been an interesting contribution of experience and knowledge," Toledo said. "The hardest thing is adapting to the altitude and dryness and the frequent use of auxiliary oxygen [due to the altitude]."

Cox can't wait for the remaining eight antennas to be installed so ALMA can be fully functional.

"What will be interesting is seeing the things that we have never thought about – those unexpected discoveries," he added.

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