with what eyes will alma observe?

The colors of light that our eyes can detect are just a small portion of the full electromagnetic spectrum. The universe emits light in many colors which are invisible to our eyes, from radio waves to gamma rays, and studies done in each band of the spectrum contribute uniquely to our knowledge.

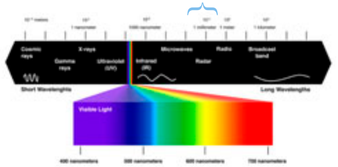
Only recently has technology allowed us to fulfill the dream of opening a new vein of high-resolution exploration observing millimetric and submillimetric waves.

This wave portion is an excellent area of research for future astronomy because:

It is where half of all light is found. In addition to the cosmic microwave background (an almost uniform glow throughout the sky resulting from the Big Bang), the Universe emits almost all of its light in two color "arrays". We`ve been studying the first one, visible light, for centuries with optical telescopes. The second, consists of far infrared colors blocked by the earth`s atmosphere and which can be observed in high resolution using observatories in space. Thanks to the incredible transparency and stability of the site where it is located and the careful selection of frequency bands, ALMA will be able to observe some of this light from Earth.

This is where the "fun stuff" is happening. Among the most profound mysteries in astronomy are the origins of phenomena such as galaxies, stars, planets and the molecules that nurture life. ALMA will observe the light emitted by cold objects in space, whether the invisible glow of clouds starting to warm up while stars form within them, or the "digital footprints" of complex molecules about which we know very little or which haven`t even been discovered yet!

Approximate range of observation of ALMA



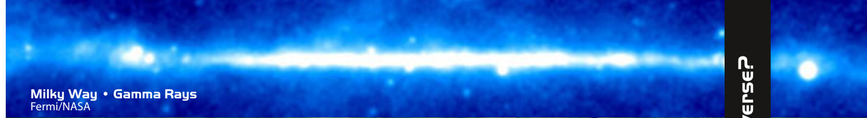
ELECTROMAGNETIC SPECTRUM

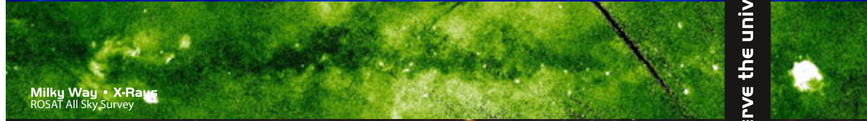
The electromagnetic spectrum is the energy distribution of the array of electromagnetic waves. This extends from short-wavelength radiation, such as gamma rays and X-rays, to ultraviolet light, visible light and infrared rays, and finally to long-wavelength electromagnetic waves, such as radio waves.

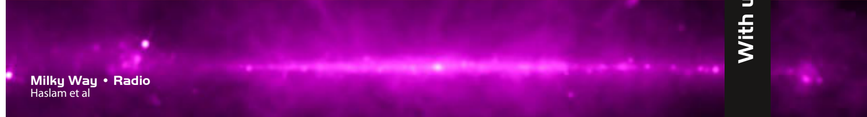
As can be seen on the cover of this brochure, the same object can be viewed in different ways depending on the waves we observe. Here we see the Milky Way in gamma rays, x-rays, visible light (what our eyes perceive), infrared and radio waves (within the range that ALMA will observe).

The Atacama Large Millimeter/submillimeter Array (ALMA), an international astronomical facility, is a partnership between Europe, North America and East Asia, in cooperation with the Republic of Chile. ALMA is funded in Europe by the European Organization for Astronomical Research in the Southern Hemisphere (ESO); in North America by the U.S. National Science Foundation (NSF) in cooperation with the National Research Council (NRC) of Canada and the National Science Council (NSC) of Taiwan; and in East Asia by the National Institutes of Natural Sciences (NINS) of Japan in partnership with the Academia Sinica (AS) of Taiwan. ALMA construction and operations are led on behalf of Europe by ESO and on behalf of North America by the National Radio Astronomy Observatory (NRAO) -which is managed by Associated Universities, Inc. (AUI)- and on behalf of East Asia by the National Astronomical Observatory of Japan (NAOJ). The Joint ALMA Observatory (JAO) provides the unified leadership and management of the construction, commissioning and operation of ALMA.

National Astronomical Observatory of Japan







With which eyes do you observe the universe?

Welcome to the ALMA universe

ALMA TIMELINE

November 2003: Start of construction

April 2005: Arrival of the first antenna to the OSF (Operations Support Facility)

February 2008: Arrival of the 10th ALMA antenna to the OSF

April 2008: First antenna on the Chajnantor Plateau

September 2009: Synchronization of 8 antennas (Chajnantor

November 2009: Operations with 16 antennas

End of 2011: First scientific observations with 16 antennas

End of 2012: ALMA inauguration

In the Atacama Desert, at an altitude of 5,000 meters, the largest Earth-based observatory in the history of humanity grows day by day. It is so large and complex that a coalition of scientists and engineers from around the world was required to design and build it.

It is a triumph of engineering and opens the door to unexplored frontiers, where it will hopefully supply answers to questions that other observatories have not been able to provide.

ALMA is the Atacama Large Millimeter/submillimeter Array.

- Llano de Chajnantor, altitude of 5,000 meters
- Atacama Desert, Chile
- 66 antennas forming one single telescope
- A global partnership between Europe, North America, East Asia and Chile

What is ALMA?

ALMA is the largest astronomical project built on the surface of the Earth.

It is a revolutionary telescope made up of 66 antennas which are 12 meters and 7 meters in diameter, designed to observe millimetric and submillimetric wavelengths. The project is being built by an international consortium on the spectacular Chajnantor plateau, at an altitude of 5,000 meters in Chile's Atacama Desert.

ALMA will revolutionize modern astronomy by enabling us to view the formation of the stars at the dawn of the Universe and obtain extremely detailed images of stars and planets as they are forming.

What is a radio telescope?

Unlike optical telescopes, like the one invented by Galileo Galilei more than 400 years ago which only captures images from the visible light spectrum, radio telescopes are designed to capture radio waves emitted by sources in space. To capture the weakest signals requires a very large surface for data collection. This requires several parabolic antennas that work together like one large telescope, as in the case of ALMA.

More antennas provide greater capacity to collect waves and distinguish details (which in technical terms we call spatial resolution).

Why so high? Why so dry?

The principal enemy of millimetric and submillimetric radio astronomy is humidity, because water vapor present in the atmosphere distorts signals from space. To avoid this, it was necessary to place the antennas in the highest, driest place possible. After many years of searching, scientists determined that the Chajnantor plateau, at an altitude of more than 5,000 meters in the Atacama Desert, was the best place in the world.

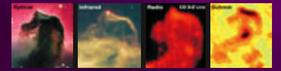
Also, it had to be a very flat location so that the 66 ALMA antennas can form different configurations with a minimal altitude difference between them.

Chajnantor plateau • 5000 m

How will ALMA "see"?

For more than four centuries, telescopes of all kinds have delighted us with intriguing, surprising and humbling images.

With ALMA, the mysterious luminescence of the coldest, darkest universe will be revealed in all its splendor. We will be able to contemplate, in vivid clarity, what no optical telescope has ever seen. All these sectors of the universe that seemed empty and uninteresting will now be illuminated for us with an unprecedented clarity.



The light of a same region in the sky as seen with different telescopes.

So many antennas!

The only way to obtain a clear image of light with long wavelengths is by building a very large telescope.

To observe with the minimum clarity what the human eye can observe in visible light, a millimetric wave telescope must be 500 times wider than the human eye. That`s why the largest number possible of antennas must work together like one giant telescope.

The ALMA telescope, made up of 66 antennas, will be able to capture details with at least 10 times more resolution than the Hubble Space Telescope.

Transporters

A transporter moving an antenna.

Depending on what you want to observe, the antennas can be placed closer together (greater sensitivity to observe large spaces in the universe) or further apart (greater collection capacity to observe more details). To transport them and form these configurations, ALMA has two transporters which were made just for this purpose. They are incredibly powerful... each one weighs 140 tons and they are capable of easily moving a 100-ton antenna.

What will ALMA discover?

STARS

Stars shine for millions and millions of years, but their formation has remained a mystery, since visible light telescopes are unable to see inside the dusty gas concentrations that give birth to stars.

PLANETS

It has always been believed that planets form around a new star by condensing in a disk of gas and molecular dust embedded in a larger molecular cloud. The condensations grow and become giant planets. The gas that remains in the disk eventually disappears, leaving planets and a disk of dust and debris.

ALMA will be able to study these unknown phases of formation, plumbing these phenomena in high resolution and detecting the light of future planets as they grow.

MOLECULES

The microscopic landscapes of grains of dust in space contain chemical factories of amazing complexity. The chemical elements join to form molecules. This process continues and diversifies as molecules are freed from the dust by warming, becoming gaseous molecules in space. The molecules created this way provide young planets with the fundamental pillars of life. ALMA will have an unprecedented ability to discover and measure the presence of molecules and their distribution in space. We will learn about the chemistry of space, which can`t be reproduced in laboratories on Earth, and the changing conditions that drive it.

ALMA is a scientific feat that will provide us with an enormous window into the universe that undoubtedly will surprise us with discoveries we haven`t yet imagined.

One of ALMA's 66 antennas "observing" the Universe.