ALMA Technical Summary

Array	
Number of Antennas	64
Total Collecting Area (ND^2)	7238 m^2
Total Collecting Length (ND)	768 m
Angular Resolution	0."2 lambda (mm)/baseline (km)
Array Configurations	
Compact: Filled	150 m
Intermediate (2)	500 m, 1500 m
Precision Imaging	4.5 km
Highest Resolution	12.0 km
Antennas[1]	
Diameter	12 m
Surface Accuracy	20 micrometers RMS
Pointing	0."6 RSS in 9 m/s wind
Path Length Error	< 15 microns during sidereal track
Fast Switch	1.5 degrees in 1.5 seconds
Total Power	Instrumented and gain stabilized
Transportable	By vehicle with rubber tires
Receivers[2]	
91 - 119 GHz HFET or SIS	T(Rx) < 50 K
211 - 275 GHz SIS	T(Rx) < 6*h*nu/k SSB
275 - 370 GHz SIS	T(Rx) < 4*h*nu/k DSB
602 - 720 GHz SIS	T(Rx) < 5*h*nu/k DSB
Dual polarization	All frequency bands
Intermediate Frequency (IF)	
Bandwidth	8 GHz, each polarization
IF Transmission	Digital
Correlator	
Correlated baselines	2016
Bandwidth	16 GHz per antenna
Spectral Channels	4096 per IF

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[3]The antenna specifications are detailed in *Request for Proposals for a Prototype Antenna for the Millimeter Array/Large Southern Array*, dated March 30, 1999.

[2]These four frequency bands are those required on the *first-light* ALMA as specified by the joint US-European ALMA Science Advisory Committee at the committee meeting of March 11, 2000. Receivers in six additional atmospheric windows are deferred to the Project options list for support from possible unallocated Project contingency funds.

ALMA *Top Ten* Science Objectives

1. To make precise images of the redshifted dust continuum emission from evolving galaxies at epochs of formation as early as z=10 (that is, within the first 2 billion years following the big bang). This will tell us how the shape, size, mass and appearance of galaxies changes as the universe ages and small galaxies merge to become large galaxies like the Milky Way.

2. To trace through molecular and atomic spectroscopic observations the chemical composition of star-forming gas in galaxies throughout the history of the universe. The goal is to understand how the star formation process depends on the increasing abundance of elements in the universe heavier than hydrogen. These *heavy elements* result from the nuclear processing in the interior of stars that causes stars to shine. The products of this nuclear processing are expelled in supernova explosions at the end of a star's life.

3. To reveal the kinematics of obscured galactic nuclei and Quasi-Stellar Objects on spatial scales smaller than 300 light-years. The motion of gas near the center of a galaxy will tell us whether or not a massive black hole at the galaxy center determines the dynamics of the entire galaxy and/or the details of the subsequent evolution of that galaxy.

4. To assess the influence that chemical and isotopic gradients in galactic disks have on the formation of spiral structure. Here the question to be answered is this: Does the increasing abundance of heavy elements with time in a galaxy affect the galaxy appearance or dynamical motion?

5. To image gas-rich, heavily obscured regions that are spawning protostars, protoplanets and pre-planetary disks. Observations at millimeter and submillimeter wavelengths allow us to see clearly through the shroud of gas and dust that envelops galaxies, stars and planets while they are first forming. Clear ALMA images of that process will permit us to see whether galaxies, stars and planets form individually or in groups; and they will give us the size and mass of those objects or groups of objects.

6. To explore the chemistry of carbon-bearing molecules in regions of star formation in order to understand the formation, abundance and distribution of the organic molecules necessary for life.

7. To determine the temperature of the photosphere, or outer layer, of thousands of nearby stars in every part of the Hertzsprung-Russell diagram. ALMA will make direct measurements of the gas temperature in the outer layers of all types of stars and it will determine the change of that temperature with depth into the photosphere.

8. To reveal the crucial isotopic and chemical gradients within circumstellar shells that reflect the chronology of invisible stellar nuclear processing. As stars age they expel their outer layers in which hydrogen has been converted to heavy elements via the nuclear processes that provide the star's light and heat. ALMA will *read* the outward gradients in element and isotope abundances like tree rings giving the history of the nuclear processing that has occurred in each star.

9. To obtain unobscured, sub-arcsecond images of all solid bodies in the solar system. Detailed images will be made of all the planets and their moons. Changing surface features, such as the volcanoes on Jupiter's moon Io, will be monitored over time. Astrometric and astronomical observations will be made of cometary nuclei, asteroids and especially of the distant and rich reservoir of icy bodies known as "Kuiper belt objects", that circle the sun beyond the orbit of Neptune. These observations can be done with ALMA during daylight or nighttime hours;

10. To image solar active regions and reveal the physical processes by which relativistic sub-atomic particles are produced and accelerated on the surface of the sun. A related goal is to understand how those particles propagate through the solar system and affect conditions on the Earth.