Smithsonian Astrophysical Observatory

The Smithsonian Astrophysical Observatory (SAO) is a research bureau of the Smithsonian Institution devoted to the investigation of those physical processes that determine the nature and evolution of the universe. Founded in 1890 as a center for "the new astronomy," SAO pioneered studies of the relationship between solar and terrestrial phenomena. In the early days of the Space Age, SAO established and operated a worldwide network of satellite tracking stations, including one on the island of Maui, and developed experiments for some of the first orbiting space observatories. Today, SAO is a member of the Harvard-Smithsonian Center for Astrophysics with headquarters in Cambridge, Massachusetts, where a combined staff of more than 200 scientists cooperate in a broad program of astronomy, astrophysics, and space sciences supported by Federal appropriations, university funds, and contracts and grants. These scientific investigations, touching on almost all major topics in modern astrophysics, include atomic and molecular physics, high-energy astrophysics, optical and infrared astronomy, planetary sciences, radio and geoastronomy, solar and stellar physics, and theoretical astrophysics. In addition to the planned Submillimeter Array facility in Hawaii, SAO maintains major data-gathering facilities at the Whipple Observatory in Arizona and the Oak Ridge Observatory in Massachusetts.

For More Information:

On the SMA...
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On Smithsonian Institution museums and programs...
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MRC 421 • Washington, DC 20560
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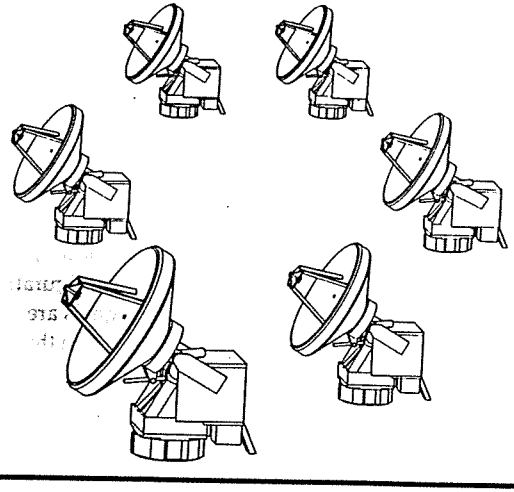
SMITHSONIAN SUBMILLIMETER ARRAY

Exploring Astronomy's Last Frontier



Smithsonian Institution
Astrophysical Observatory
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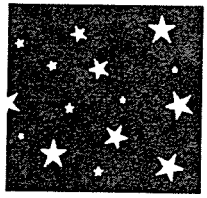
Mauna Kea, Hawaii

SUBMILLIMETER ASTRONOMY – THE UNEXPLORED FRONTIER

The submillimeter region of the electromagnetic spectrum has been called "the last frontier" of ground-based observational astronomy. Lying in the band of wavelengths between radio and infrared radiation, the submillimeter region has remained largely unexplored because the technology to produce the precisely shaped antennas and highly sensitive receivers needed for its detection did not exist until recently.

Now, using advances in antenna fabrication, detector design and computer support, the Smithsonian Institution's Astrophysical Observatory is constructing the Submillimeter Array (SMA), a unique instrument to observe many astronomical objects and phenomena now obscured or extremely difficult to study from Earth. When operational in 1997, the SMA will probe the murky dust clouds of the Milky Way where stars are born, peer into the hearts of distant exploding galaxies, and study cool faint objects of our own solar system, including comets and planets.

Star Birth



Although they are the building blocks of the universe, little is known of how stars are conceived, born, and grow to maturity because this vital process takes place deep within light-blocking clouds of dust and gas. Since submillimeter radiation penetrates these clouds, the SMA will be able to observe those dense clumps thought to be the seeds of stars, to track the flattened disks of material spinning down into stellar bodies, and to measure the brightness of otherwise invisible new young stars.

Quasars and AGNs

The most distant and most powerful objects in the universe, quasars may each emit as much energy as an entire galaxy. Active galactic nuclei (AGNs), that is, the violently churning cores of distant galaxies, may offer clues to the source of this extraordinary power. In fact, the high angular resolution of the SMA will allow astronomers to look deep into AGNs to see if intense starburst activity, massive black holes, or some still unimagined phenomena, are responsible for the energy.

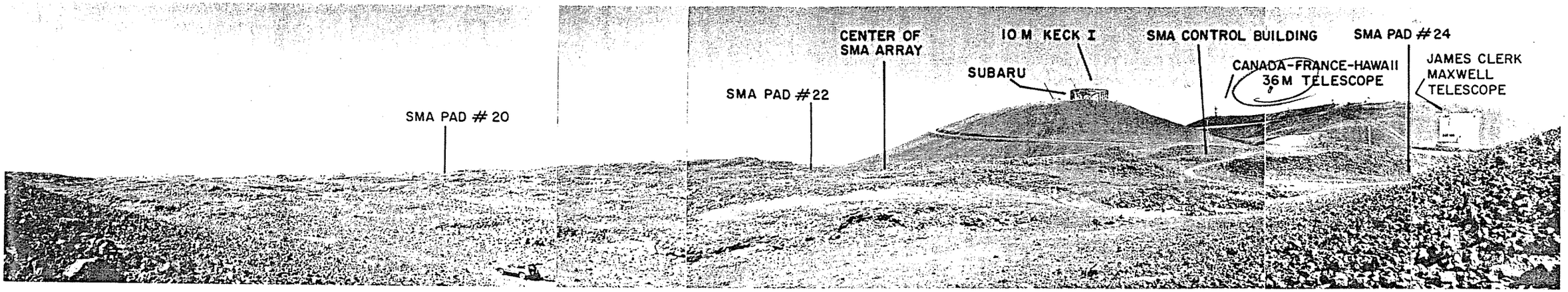
Galaxies

The SMA's unusual sensitivity to submillimeter radiation from molecules of gas and dust will allow it to make detailed maps of distant galaxies. High resolution SMA images can show the relative positions of dust, stars, and gas in the spiral arms, thus leading to a better understanding of how giant molecular clouds form, as well as how the total mass and luminosity are distributed in galaxies.

Solar System

Although the SMA can image many objects of the solar system, the most interesting submillimeter observations may be of planetary atmospheres and surfaces, for example, taking the temperature of regions beneath the surface of Venus or tracing weather patterns in its steamy upper atmosphere. The SMA may also be able to map features on some asteroids and measure the mass lost from comets when swept out in tails of dust and gas.

Smithsonian's Submillimeter Array On Mauna Kea

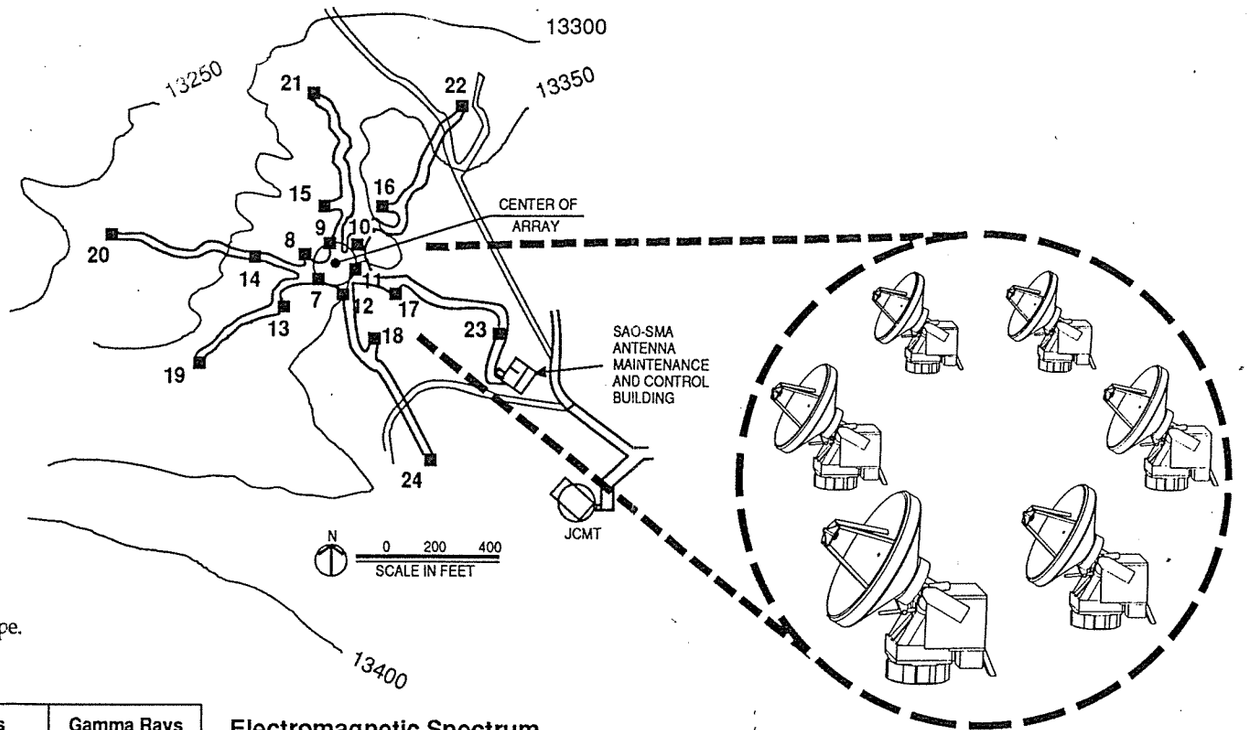


The Site

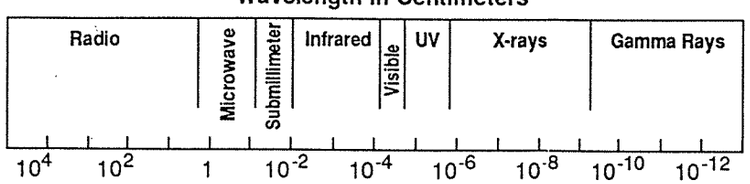
The SMA will be located just below the 4200-meter (14,000-foot) summit of Mauna Kea, Hawaii, in an area dubbed "Millimeter Valley" for the clustering there of several instruments operating at these wavelengths. The site will be subleased from the University of Hawaii, which administers the Mauna Kea Science Reserve.

Because submillimeter radiation can be obscured by water vapor in the Earth's atmosphere, the SMA required a high, dry location, as well as one with sufficient space to allow the large separations between antennas. Mauna Kea meets both these requirements and, because it lies close to the Equator, also offers excellent views of the area around the galactic center, location of many star-forming regions and other interesting astronomical objects.

A system of widely spaced concrete pads allows placement of the separate antennas in various configurations. The control building, where individual signals are received and combined as one, is at far right in this schematic, near the James Clerk Maxwell 15-meter radio telescope and the 10-meter Caltech Submillimeter Telescope.



Wavelength in Centimeters



Electromagnetic Spectrum

The SMA will observe radiation in the 1.3 to 0.3 millimeter wavelength region, a band lying between infrared and radio and popularly called "submillimeter waves." (A millimeter is one-thousandth of a meter, or about four-hundredths of an inch.)

The Instrument

The Submillimeter Array (SMA) consists of six, 6-meter-diameter, movable antennas capable of being positioned by a wheeled transporter to create an interferometer with various configurations. When placed at their widest separation, the individual elements act like a single, giant antenna about 500 meters (1500 feet) wide. Using a signal correlator to combine and integrate the radiation received by each of the six antennas, the SMA will produce images of astronomical objects with a resolution comparable to the best optical telescopes and more than 10 times that of any existing single-dish submillimeter telescope.

To minimize the environmental impact on this site, the pad system is linked by unpaved service roads, reached by a transporter equipped with oversized (1.8-meter-high), low-pressure tires. The giant vehicle is designed to lift and carry loads up to 30 tons, and will travel at about 8 kilometers per hour (5 mph) over Mauna Kea's rough terrain when moving antennas to different locations.