The Cornell Caltech Atacama Telescope (CCAT)

Simón J. E. Radford (Caltech) on behalf of the CCAT Project

The CCAT Project

In 2004 February Cornell University and the California Institute of Technology signed an agreement that will lead to the construction and operation of a 25 m diameter telescope for submillimeter astronomy on a high mountain in the Andean highlands of the Atacama desert in northern Chile. Scheduled for completion at the beginning of the next decade, this Cornell Caltech Atacama Telescope (CCAT) will be the largest and most sensitive facility of its class as well as the highest altitude astronomical facility on Earth. In 2006 January, the project completed a Feasibility Concept Design Study, developing the technical specifications and evaluating possible technology approaches. An external committee reviewing the Study concluded, “The CCAT will revolutionize Astronomy in the submillimeter FIR band and enable significant progress in answering the cosmic origin of stars, planets, and galaxies. CCAT is very timely and cannot wait.” Of the two CCAT sites, that of the University of Colorado, the University of British Columbia leading a Canadian university consortium, and the UK Astronomy Technology Centre on behalf of the UK community joined Cornell and Caltech in signing an Interim Consortium Agreement to develop the project. Late in 2007, the Universities of Cologne and Bonn stated their intent to join the project. Other institutions have also expressed interest.

Scientific Objectives

Combining high sensitivity, a wide field of view, and a broad wavelength range, CCAT will be an unprecedented capability to make deep, large area multIWavelength submillimeter surveys that address a large variety of astrophysical problems. Highlights include: Galaxy formation and evolution. CCAT will detect hundreds of thousands of high redshift submillimeter starburst galaxies, allowing investigation of the star formation history of the early universe and of the evolution of the ionization, the luminosity distribution, and the clustering of these galaxies. Dark Matter and dark energy. CCAT’s high resolution images of the Surveyor-Zel’dovich effect in hundreds of clusters of galaxies will illustrate in detail how clusters form and evolve, aiding the determination of the dark energy equation of state and other cosmological parameters from SZ surveys. Star Formation. CCAT will provide the first complete census of cold, dense Galactic molecular cores that collapse to form stars. In nearby clouds, CCAT will detect 5000 Mg lines, smaller than the lowest mass stars. Protostellar and debris disks. CCAT will survey nearby young star clusters to determine the prevalence and evolution of protoplanetary and debris disks, identifying targets for high-resolution imaging with ALMA. The Kepler-JWST. CCAT will determine basic physical data – sizes and albedos – for hundreds of Kepler-JWST objects.

Project Schedule

Feasibility Concept Design Study
2005-2006
Feasibility Study Review
2006 Jan
Technical Development
2006-2007
Subsystem Development
2008-2010
Construction & Integration
2010-2013
Commissioning
2013-2014

CCAT/350

Submm Galaxy Surveys

CCAT will detect hundreds of thousands of submillimeter galaxies from the most intense era of galaxy formation at z ∼ 1–4. This enormous rich catalog will identify prime candidates for follow up and detailed study with ALMA. Here you estimate the submillimeter galaxy detection rate for CCAT with a modest 32 × 32 (1024) pixel camera is compared with some other facilities: JCMT/SCUBA2 at 850 μm, LMT at 1100 μm, and ALMA at 850 μm. These estimates incorporate fields of view, sensitivities, the density of galaxies on the sky, and the confusion limit (cutoff to the left). Even with this modest camera, CCAT has a much higher detection rate than the other facilities. Moreover, the planned CCAT cameras are substantially larger, further increasing the detection rate.

The Site

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The Site

During the CCAT’s scientific lifetime, bolometer arrays will become available that are many times larger than present instruments. To accommodate these large format cameras, the Ritchey-Chrétien optical design is optimized for a wide field of view. The telescope has an azimuth-elevation mount and is enclosed in a calotte style dome. Two Naoth filters outside the elevation bearings provide ample space for instruments. To achieve high aperture efficiency for short wavelengths (800 μm) observations, an active surface adjustment system will be used with closed loop positioning of the primary mirror panels. The mirror surface will be measured with holographic observations of planets. Edge sensors and optical angle and distance metrology are among the techniques under consideration for maintaining the panel alignment.

Performance Goals

Aperture
25 m diameter
Wavelength
200–2200 μm
Field of view
20°
Pointing
0.2°
Half wavefront error
10 μm rms
Primary focal ratio
6.0
Naouth focal ratio
8.0
Site
Atacama
Water vapor (median)
< 1 mm

Concept view of CCAT at 5600 m on the candidate site near the summit of Cerro Chajnantor, Chile.

Concept design of the CCAT structure. Major instruments will be mounted at the Naouth focli outside the elevation bearings. Hydostatic azimuthal bearings support the alidale.

SCUBA2 at 850 μm. These estimates incorporate fields of view, sensitivity limits and the estimated confusion levels are compared for CCAT and several other instruments.

CCAT Sensitivity

Equipped with large format bolomer arrays, CCAT offers superb sensitivity for deep surveys. Because of the wide instantaneous field of view, its mapping speed is an order of magnitude greater than any other instrument. Here the one hour, 5σ sensitivity limits and the estimated confusion levels are compared for CCAT and several other instruments.

Site evaluation instruments on the candidate CCAT site at 5612 m near the summit of Cerro Chajnantor, Chile (G. Gadl).

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Galaxy formation and evolution:

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