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CCAT and the Astro2010 Decadal Survey

Science White Papers Submitted by CCAT Consortium Members

CCAT

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Star formation drives the evolution of baryonic matter in the universe. The energy density of the Far Infrared (FIR) and submillimeter (submm) extragalactic radiation is roughly equal to that of the integrated optical and UV starlight. Comprehensive pictures of the processes of galaxy, star and planetary formation thus require high sensitivity and high angular resolution observations in that spectral region. CCAT will be a primary player in furthering our understanding of the processes of formation of cosmic structures on all scales and the characterization of star formation through cosmic time.

Searching for the Secrets of Massive Star Birth

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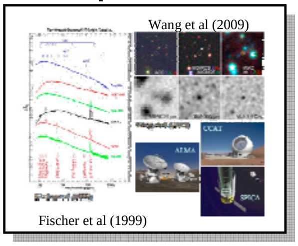
Rare, highly clustered in confused environments, and short-lived massive stars play a central role in the evolution of the both the cosmos and the Galactic interstellar medium. The large numbers of dense cores identified in CCAT surveys will be essential for understanding the process of massive star formation.

Spitzer Space Telescope IRAC image showing NGC 6334

A Complete View Of Galaxy Evolution: Panchromatic Luminosity Functions And The Generation Of Metals



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When and how did galaxies form and their metals accumulate? There is now a broad picture of the evolution of galaxies in dark matter halos: Their masses, stars, metals and supermassive blackholes. Galaxies have been found and studied in which these formation processes are taking place most vigorously, all the way back in cosmic time to when the intergalactic medium was still largely neutral. The details of how and why the interstellar medium in distant galaxies cools, is processed, recycled and enriched in metals by stars, and fuels active galactic nuclei remain uncertain.

Fragmentation in Molecular Clouds and the Origin of the Stellar Initial Mass Function

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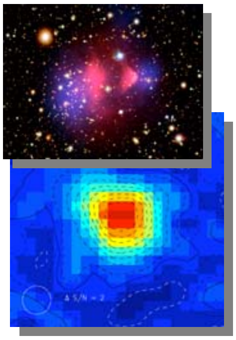
The next generation of millimeter and submillimeter telescopes will map the clump mass function below the peak in the stellar mass function and down to substellar masses. These observations will establish if the clump mass function in nearby molecular clouds follows the stellar IMF to the substellar regime, and if the clump mass function is similar over a wide range of environments in the Galaxy.

Image Courtesy of Brogan, Indebetouw & Hunter (NRAO)



Calibrating Galaxy Clusters as a Tool for Cosmology via Studies of the Intracluster Medium & Understanding the State of the Intracluster Medium in Galaxy Clusters

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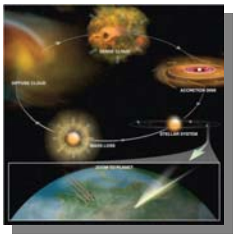
Galaxy clusters are systems with large concentrations of dark matter, galaxies, and highly heated plasma, rendering them visible over a wide range of redshifts (up to z = 2-3). Because they collapse from a large region (~10 Mpc), their contents reflect the overall properties of the universe. They thus have relatively predictable behavior, with small scatter, which makes them good tools for measuring cosmological parameters, especially the critically important possible evolution of the dark energy equation of state with time. Measuring the thermodynamic state of the intracluster medium via precise X-ray and thermal Sunyaev-Zeldovich effect observations is critical to understanding them as astrophysical objects and using them as tools for cosmology.

Image Credits: Bullet cluster: Chandra X-ray image (red), weak lensing (blue), and optical imaging of the Bullet cluster. D. Clowe et al., Astrophys. J. Lett. 648, L109 (2006) SZ image: S. Golwala and J. Sayers, Bolocam 150 GHz image of MS0451.6-0305



The Molecular Universe: From the Diffuse Interstellar Medium to Planetary Systems

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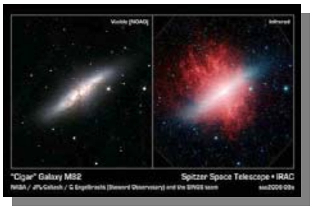
One of the central questions of modern astrophysics concerns the life cycle of molecules in the Universe – from the diffuse interstellar medium to planetary systems – and the chemical pathways leading from simple atoms and diatomic molecules to complex organic species. Recent advances in detector and digital spectrometer technologies promise to revolutionize further the field of high-resolution submillimeter spectroscopy and its application to the study of the life cycle of molecules.

Image Courtesy www.space.com



Star Formation Through Cosmic Time: From Local Galaxies to the Early Universe

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The star formation rate per unit co-moving volume in the Universe peaked when the Universe was only 15-45% of its present age (1<z<3) at values 30 times the present rate. It is important to study nearby, spatially resolved systems so that one can relate the astrophysical probes and lessons learned to the high redshift, unresolved systems.