Three Hubble Treasury Programs Selected in Cycle 11

Ages from Near-UV Spectra of Globulars and Galaxies


The ultimate goal of Hubble Treasury program G0-9455 is characterizing the age and metallicity of spatially unresolved stellar systems older than a few billion years. Heroic efforts using optical integrated-light spectra have aimed to establish the age of globular clusters and galaxies from the temperature of main-sequence turnoff stars and their metallicity from the strengths of spectral absorption lines. Our program will provide the tools to do this in the near ultraviolet (UV), where the contribution from red giants is nearly negligible, but where line absorption must be painstakingly modeled. Our near-UV STIS Space

The Hubble Treasury Program on Eta Carinae

Kris Davidson, Ph.D, kd@astro.umn.edu, Theodore R. Gull, Kazunori Ishibashi, John Hillier, Roberta Humphreys, and the Eta Car Team†

Our Hubble Treasury project to observe Eta Carinae has been held by a web of motives and applications. Though primarily focused on a mysterious spectroscopic event expected to occur in mid-2003, the data will become resources for several branches of stellar and nebular astrophysics. Also, the emission line spectrum will provide reference measures of instrumental characteristics pertinent to other archived data from the Space Telescope Imaging Spectrograph (STIS). In several respects, ours is the most intensive spectroscopic project yet attempted with Hubble. We are "pushing the envelope" for both spatial and spectral resolution on a complex target. The resulting data will be widely useful—and impressive in volume.

The ACS Contribution to GOODS

Mauro Giavalisco, Ph.D, mauro@stsci.edu, Mark Dickinson, and the GOODS Team

Our Hubble Treasury program will take deep images of two fields at high north and south galactic latitudes using the newly installed Advanced Camera for Surveys (ACS). These data sets are part of the Great Observatories Origins Deep Survey (GOODS), which is a multi-wavelength campaign of imaging and spectroscopy on these fields using three NASA Great Observatories (Hubble, SIRTF, and Chandra), the European Space Agency’s XMM-Newton, and large ground-based telescopes. The goal of GOODS is to create a community resource for exploring the distant universe and studying the evolution of galaxies—a grand, unsolved problem of astronomy that is profoundly connected to cosmology. Using these ACS images, astronomers

Continued page 3

Continued page 7

Continued page 8
will trace the emergence of the Hubble sequence and study the evolving relationships between the physical and morphological characteristics of galaxies. GOODS data will enable a wide variety of topical investigations, including star formation at high redshift, active galactic nuclei (AGN), the extragalactic background light, type Ia supernovae (SNe Ia) to probe the cosmological geometry, gravitational lensing, and the discovery of galaxies with redshifts up to $z \approx 7$.

The GOODS ACS program will cover two $10 \times 16$ arcmin regions centered on the Hubble Deep Field North (HDF-N) and the Chandra Deep Field South (CDF-S). The sky area will be larger than most previous surveys using the Wide Field Planetary Camera 2 (WFPC2)—33 times larger than the combined area of the HDF-N and HDF-S, 4 times larger than the combined HDF-N and HDF-S Fields, and 2.5 times larger than the Gronoff Strip Survey. Only the Medium Deep Survey and other Hubble parallel programs covered larger sky areas, and they did so with less sensitivity, fewer filters, and non-continuous fields.

We have chosen two fields to ensure against variance due to line-of-sight clustering effects and to enable follow-up programs by astronomers and observatories worldwide.

We will take ACS images in four broad, non-overlapping filters: F435W (B), F606W (V), F775W (i), and F850LP (z), with exposure times of 3, 2.5, 2.5, and 5 orbits, respectively. We will image each field in five visits separated by about 45 days to search for high-redshift supernovae. The extended-source sensitivities of the combined images will be only 0.5-0.8 magnitudes shallower than the WFPC2 HDF observations.

The target fields are the most data-rich and best-studied deep-survey areas on the sky. In addition to optical and near-infrared imaging, the fields have been subjects of extensive spectroscopic, radio, and sub-mm surveys, and the deepest X-ray observations from Chandra and XMM-Newton. The GOODS SIRTF Legacy program (M. Dickinson, PI) will make the deepest observations of these fields at 3.6 to 24 microns. We are also carrying out optical and near-infrared imaging and spectroscopy using facilities at the European Southern Observatory, National Optical Astronomy Observatory, Gemini, and Keck.

The HDFs became a scientific phenomenon by attracting many researchers with varied interests and approaches. Indeed, the HDFs catalyzed the deepest observations of all sorts, at many wavelengths, and by the most powerful telescope facilities in space and on the ground. Nevertheless, the HDFs have limitations. First, they are very small fields—5 square arcmin each—probing small co-moving volumes. Second, their wavelength coverage has an important gap in the mid- and far-infrared. ISO and SIRTF observations of the HDF at 7, 15, and 850 microns detect only a small number of the most luminous, dust-obscured objects and do so at wavelengths that miss the peak of dust re-emission. As a result, HDF studies of AGN and galaxies at $z \approx 1$ are missing both near-infrared, rest-frame light, which traces total stellar mass, and the mid- and far-infrared light, where most of the bolometric luminosity from star formation and dust-obscured active nuclei must emerge.

GOODS will extend the lessons and address the shortcomings of the HDFs. The GOODS ACS observations will cover much larger areas, and the GOODS SIRTF data at 3.6 to 24 microns will fill the "infrared gap." Additionally, Guaranteed Time Observers will acquire SIRTF data down to 170 microns, albeit at brighter flux limits.

The GOODS ACS observations will image large samples of galaxies and AGN at 0.5 < $z$ < 6.5 with sub-kiloparsec resolution. Deep $z$-band images will measure the optical rest-frame morphologies of galaxies out to $z \approx 1.3$. With multiple epochs, the ACS observations should detect $\sim 12$ SNe Ia at 1.2 < $z$ < 1.8, suitable for measuring the predicted transition from cosmological deceleration to acceleration. Complemented by ground-based spectroscopy and the SIRTF infrared photometry, the ACS images will

---

**Figure 1.** Layout of the ACS observations for GOODS. The grid of white boxes shows the tiling of ACS fields at one telescope orientation superimposed on the Chandra (outer greyscale) and SIRTF (inner greyscale) exposure maps. We will revisit the fields approximately every 45 days to enable a search for high-redshift, type Ia supernovae. The inset schematically shows how the ACS field of view rotates and tiles at different epochs of our Hubble Treasury observations.