THE GALAXIES AND COSMOS EXPLORER TOOL

CHARTING GALAXIES OVER COSMIC TIMES IN THE CLASSROOM

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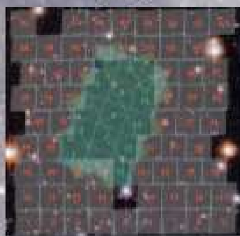
WWW.AS.UTEXAS.EDU/GCET



SUMMARY

Recent large galaxy surveys conducted with NASA's Hubble Space Telescope Advanced Camera for Surveys (ACS) have provided unprecedented legacy datasets, which allow astronomers to charter the evolution of galaxies over a large fraction of the age of the Universe. The Galaxies and Cosmos Explorer Tool (GCET, http://www.as.utexas.edu/gcet/) is an online web-based tool that allows the general public and students to actively participate in this exciting adventure through quantitative analyses of HST images from the Galaxy Evolution from Morphology and SEDs (GEMS) survey, one of the widest-area galaxy surveys conducted in two filters with ACS to date. The tool allows users to surf the vast cosmos and access ACS images of over 8,000 galaxies over the last eight billion years. For galaxies of interest, users can measure the size, determine the lookback time for concordance cosmology, perform morphological classification on images at two rest-frame wavelengths, and gage the different stellar populations present. Users can record their measurements, as well as reference information, such as coordinates and redshift, of each galaxy into Excel spreadsheets for further analysis. The celestial coordinates can be used to extract further multiwavelength data from existing archives and upcoming virtual observatories. For undergraduate classes, more advanced IDL or C-based analyses that employ the full samples, can be combined with the visualization capabilities of GCET in order to explore the nature of interesting objects, such as the most massive galaxies, starbursting systems, as well as interacting and merging galaxies. GCET provides a powerful tool for discovery learning in undergraduate introductory science classes as well as high schools.

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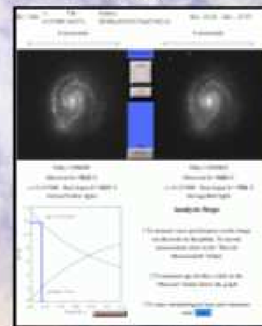
(TO THE LEFT) **FIG. 1** - From the browse page - an overview of the 30' by 30' area mapped at high resolution and in two filters by the GEMS survey (Rix et al 2004) using the ACS camera aboard the Hubble Space Telescope. The 78-tile mosaic of GEMS overlaps with the central 15 tiles covered by the GOODS (Giavalisco et al 2004) survey. Redshifts are from the Combo-17 ground-based data (Wolf et al 2004). **FIG. 2** - Tile 57 HST image. The superior spatial resolution (0.08") resolves components of galaxies. **FIG. 3** - Tile 57 ground-based image: students can observe how the low resolution (~1.8") blurs out galaxies in comparison with the space-based image.



FIGS. 4, 5, & 6 - Detailed structure elements are resolved in the GEMS data, and students are able to measure features like bulges, disks, spiral arms, and distortions. (Fig 4 - an interacting galaxy with z=0.7, Fig. 5 - an elliptical galaxy with z=0.7, Fig. 6 - an interacting system with z=0.3.) The images are a composite of both the F850LP and F606W bands.

FIG. 7 - The individual galaxy window equips students with measuring tools for images from both the ACS F606W and F850LP filters. Comparing these images allows instructors to introduce band-pass shifting and its effects. Students are able to click the "Measure Age" button which converts the galaxy's redshift into lookback time, which is then recorded in the "Analysis" window (see Fig. 8).

FIG. 8 - Students are able to save their measurements and visual classification for each galaxy image, and all of their data can be downloaded later into a spreadsheet for further analysis.

EXAMPLE OF GCET APPLICATION

Advanced students are able to use GCET as a visual aid in their analysis of GEMS data. While learning to create plots in programming languages such as IDL, students can use GCET to view some of the more interesting galaxies.

For example, if a student were to make a plot of the star formation rate vs. mass in a specific redshift regime of interest (**Fig. 9**), the student could then extract the most massive, star-forming galaxies to view with GCET (**Fig. 10**). This allows the student not only to take their analysis further with visual classification, but also to view these galaxies and systems in their environmental context on the GEMS tile. Students can see for themselves if the most massive, star forming galaxies occur in clusters or in relative isolation. Using the GCET measuring tools, students will be able to calculate the sizes of certain characteristics of interest within the galaxy, for instance a star forming region.