GALEX (THE GALAXY EVOLUTION EXPLORER)

LUCIANA BIANCHI[1,2], AND THE GALEX TEAM [3]
[1] *JHU Center for Astrophysical Sciences, Baltimore, USA*
[2] *Astronomical Observatory of Torino, Italy*
[3] *CIT, JHU, LAS, CAL, UC Berkeley*

ABSTRACT.
GALEX (The Galaxy Evolution Explorer) is a NASA Small Explorer (SMEX) mission, planned to fly in 2001 (see Bianchi et al 1998, 1999a, Martin et al 1999). GALEX will perform a series of spectroscopic and imaging surveys in the space ultraviolet band (1300-3000Å), that will map the history and probe the causes of star formation over the $0 < z < 2$ range, 80% of the life of the Universe, a period of dramatic evolution, when most stars, elements, and galaxy disks were formed. GALEX will provide a direct measurement of each the redshift, extinction, and star formation rate (UV luminosity) in 100,000 galaxies, with efficient slitless grism spectroscopy. It will determine whether rapid evolution has occured in the star formation rate, or in the extinction or initial mass function. The GALEX database will furnish a direct link between rest frame UV properties of galaxies seen locally to those that dominate the faint blue galaxy population. As such, it will provide a framework for the interpretation of the deepest HST images and those that may be obtained by the NGST.

The GALEX mission will produce an unprecedented all-sky map in two UV bands (deeper than existing surveys at other wavelengths) and an unbiased catalog of UV sources, and will fill in the crucial missing piece of the spectrum so that our knowledge of the sky from 100 μm to 10Å is complete. The GALEX science data archive design is described in this book (Bianchi et al 1999c) and by Bianchi et al (1999b).

1. Science Goals and the GALEX Mission

The primary goals of GALEX are focused on the following questions:

- What are the UV properties of local galaxies, and how do rest UV properties, measured at high redshift by HST and NGST in their search for galaxy *origins*, relate to star formation rate (SFR), extinction, metallicity, and burst history?
- What is the star formation and metal production *history* of galaxies over the redshift range $0<z<2$? When and where did stars and elements see today have their *origins*? And does this history explain the dramatic *evolution* suggested in previous surveys?
- What global (galaxy-wide) factors drive star formation and its evolution in galaxies?

To provide answers, GALEX will produce an unprecedented, statistically powerful database of UV images and spectra of nearby and distant galaxies, linked to a multiwavelength archive (Bianchi et al., this book). Using UV properties, supplemented by measurements at other wavelengths, GALEX will derive global parameters for each galaxy: star formation rate (from UV luminosity), extinction (from UV slope), initial mass function (IMF), starburst parameters *versus* redshift, and characterize their relationship to galaxies properties (luminosity, type, metallicity, neighborhood, gas supply) and their evolution by comparing statistical distribution of these parameters to cosmological models of the history of galaxies and QSOs.

GALEX will address these goals with the following set of measurements:

Imaging: Two imaging surveys in a Far-UV (1350-1850Å) and Near-UV band (1850-3000Å) with 4-5″resolution and <1″astrometry, and a cosmic UV background map:

- AIS: An All sky Imaging Survey to $\approx 21^m$ (AB), netting $\approx$ 10,000 galaxies within 70 Mpc and providing an unbiased local calibration of UV galaxy morphology, SFR, and extinction.
- DIS: A Deep Imaging Survey over 160 square degrees to 26^m (AB) to provide photometric redshifts ($0 < Z < 2$), extinction, and SFR for the faintest and most distant galaxies.

Spectroscopy: Three overlapping objective-grism Spectroscopic Surveys over the 1350-3000Å band with $\lambda/\Delta\lambda \approx 150$, resulting in measurements of redshifts ($0 < z < 2$), extinction, and SFR, for >100,000 galaxies, with **no follow up required**.

- WSS: A Wide-field Spectroscopic Survey to 20-22^m (AB) over 160 square degrees to calibrate the global UV/SFR/Extinction relations and find the rarest and most-luminous star-forming galaxies.
- MSS: A Medium-deep Spectroscopic Survey to 22-24^m (AB) over 16 square degrees to find star forming galaxies of intermediate SFR and redshift.
- DSS: A Deep Spectroscopic Survey to 23-25^m (AB) over 2 square degrees to find the galaxies with the lowest SFR and highest z, overlapping the deepest ground-based surveys.

Tab. 1 - GALEX mission summary

Parameter	Far UV	Near UV
Band	1350-1850 Å	1850-3000 Å
Field of View	1.25 degrees	1.25 degrees
Angular Resolution (80% EE)	4.0 ″	4.4 ″
Spectral Resolution $\lambda/\Delta\lambda$	$\approx$ 200	$\approx$ 100
Redshift Range	0<z<1	1<z<2
Effective Area (imaging)	50 cm^2	44 cm^2

Tab. 2 - GALEX survey summary

Survey (⋆)	Area [deg^2]	Duration [months]	T(exp) [Ksec]	Mag.Limit [m_{AB}]^a FUV – NUV	No.Galaxies	N. QSOs
AIS	41,000	4	0.08	21.0^b – 21.2^b	10^7	700,000
DIS	160	4	17	26.0^b – 25.3^b	10^6	300,000
WSS	160	4	17	$20.2/22.7^{b/c}$– $19.7/21.7^{b/c}$	40K/200K	5K/10K
MSS	16	4	170	$22.0/24.0^{b/c}$– $21.3/23.1^{b/c}$	20K/100K	1K/2K
DSS	2	4	1500	$23.0/24.8^{b/c}$– $22.5/24.3^{b/c}$	10K/40K	1K/2K
AIP	–	4	–	–		

(⋆) AIS = All Sky Imaging Survey, DIS = Deep Imaging Survey, WSS = Wide-field Spectroscopic Survey, MSS = Medium Spectroscopic Survey, DSS = Deep Spectroscopic Survey, AIP = Associate Investigator Program
(a) AB mag @ 2000Å = -2.5 log f_ν -48.6
(b) High S/N ; (c) Low S/N

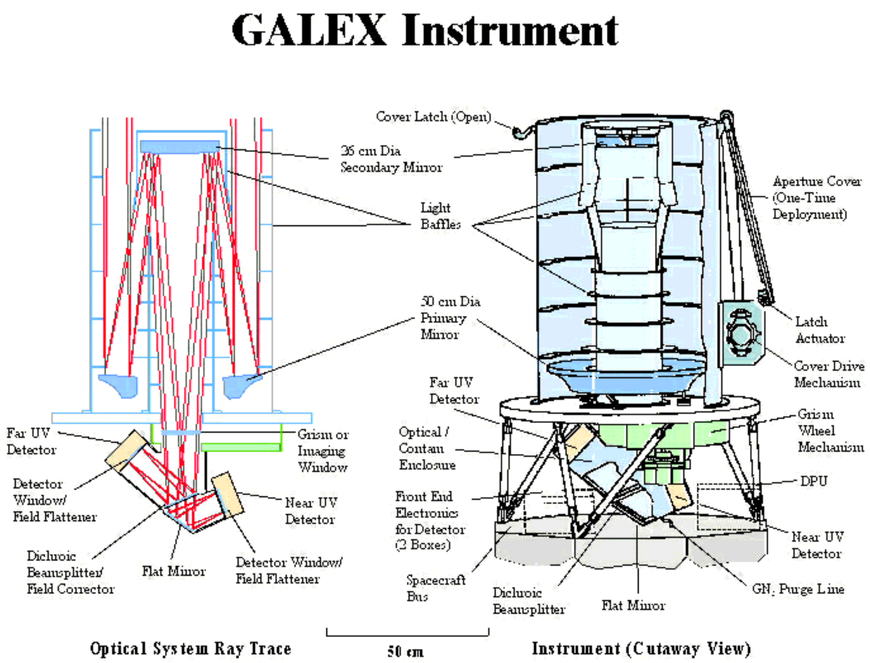

Fig. 1. GALEX instrument: (*left:*) optical design; (*right:*) mechanical configuration.

Tab. 3- GALEX Science Team

Name (a)	Affiliation	Role/Responsibility
Christopher Martin ⋆	Caltech	Principal Investigator
Luciana Bianchi ⋆	JHU	Science Data Archive
Peter Friedman ⋆	Caltech	Project Scientist
Bruno Milliard ⋆	LAS, F	Optics
David Schiminovich ⋆	Caltech	Instrument Scientist, SODA
Oswald Siegmund ⋆	UC Berkeley	Detectors
Jose Donas	LAS, F	
Tim Heckman	JHU	
Genna Kanner	AUSD	
Barry Madore	Caltech	
Roger Malina	UC Berkeley	
Michael Rich	CAL	
Alex Szalay	JHU	
Young-Wook Lee	Center for Space Astrophys. Yonsei	
Yong-Ik Byun	Center for Space Astrophys., Yonsei	

2. The GALEX Instrument

The 28 months mission is performed with a standard 3-axes spacecraft with modest pointing requirements, and a 50cm f/6 corrected Ritchey-Cretien telescope equipped with two MCP cross-delay-line detectors. An aspheric curvature on the dichroic beam-splitter corrects field aberrations over 1.25 degrees. The grism corrects spectral coma aberration. The primary-secondary metering structure is an invar Meinel spider.

3. Associate Investigator Program

The GALEX UV survey mission is capable of addressing a large number of important astrophysical issues, as well as providing a fundamental database. The most significant scientific breakthroughs that we expect from GALEX are described by Bianchi et al (1998). An effective way to exploit the broad scientific potential is an Associate Investigator Program (AIP), that will support competitively won investigations to analyze the GALEX data and/or dedicated imaging or spectroscopy observations. Four months are baselined in the mission for the AIP (see Table 2).

References

Bianchi, L., Martin, C., et al.: 1998, in *UV Astrophysics beyond the IUE Final Archive*, R. Gonzalez-Riestra, W.Wamsteker and R.A. Harris eds., ESA SP-413, p. 797.

Bianchi, L., et al.: 1999a, *Mem. Soc. Astron. It.* , Vol.70 N.2, in press

Bianchi, L., Szalay, A., et al.: 1999b, in *UV-Optical Space Astronomy beyond HST*, J.M. Shull, A.L. Kinney and J.A. Morse eds., ASP Conference Series, **164**, p. 194.

Bianchi, L., et al.: 1999c, this book.

Martin, C., Bianchi, L., et al. 1999 in *UV-Optical Space Astronomy beyond HST*, J.M. Shull, A.L. Kinney and J.A. Morse eds., ASP Conference Series, Vol. 164, p.182.