GALEX

Project Data Management Plan

Science Operations Center (Caltech)

Version 1.0

December 17, 2002

Contents

1. Introduction

This document describes the Project Data Management Plan for the GALEX (Galaxy Evolution Explorer) mission. GALEX is a NASA Small Explorer (SMEX) mission with launch scheduled for February, 2003.

1.1. Purpose and Scope

This PDMP is designed to be consistent with the GALEX Level-1 Requirements Definition Document. It will describe the generation and delivery of GALEX science data products to the GALEX Science Operations Center (SOC) and elsewhere, institutional responsibilities for data analysis and the ultimate transfer of archival data products to the National Space Science Data Center (NSSDC). Covered in this plan are:

1) Description of the GALEX instrument
2) Description of the data flow
3) Description of the science data products
4) Processing requirements and facilities
5) Policies for access and use of GALEX data
6) Data product documentation

Much of the material in this plan is also described in the SODA to MAST Interface Control Document. While this document describes the GALEX project data management plan, the SODA-MAST ICD supercedes this document with respect to a detailed description of the SODA to archive interface.

1.2. PDMP Development, Maintenance, and Management Responsibility

The GALEX Principal Investigator, Dr. Christopher Martin of the California Institute of Technology, is responsible for the development, maintenance and management of the PDMP through the life of the mission. Two points of contact for the PDMP are Dr. David Schiminovich, GALEX Co-Investigator and Instrument Scientist and Dr. Susan Neff, GALEX Mission Scientist. The GALEX PDMP will be modified and updated as required in accordance with the Configuration Management Plan for SMEX Missions.

2. Project Overview

The Galaxy Evolution Explorer (GALEX) mission was selected in October 1997 as a result of AO-97-OSS-03 fo SMEX missions. GALEX is managed by the California Institute of Technology and JPL, under contract from the NASA Small Explorers Office at GSFC. Spacecraft and mission operations center (MOC) are provided by Orbital Corp., Dulles, Va. Universal Space Networks operates the ground station network under a subcontract with Orbital. Caltech is the location of the Science Operations Center (SOC) and provides science and technical oversight for the mission. The GALEX science team includes co-investigators from Caltech, Johns Hopkins, IPAC/OCIW, LAM (Laboratorie Astronomie Marseilles), UC Berkeley, UCLA and CSA-Korea.

GALEX Mission Confirmation was granted in March, 1999 (?). The GALEX mission is scheduled to be launched in February 2003.

2.1. Science Objectives

GALEX will perform the first space ultraviolet sky survey. Imaging surveys in two bands (1350-1750Å and 1750-2700Å) will include an all-sky survey (limit $m_{AB} \sim 20-21$), a medium-deep imaging survey (limit $m_{AB} \sim 22-23$) and a deep survey of 100 square degrees (limit $m_{AB} \sim 26$). Spectroscopic grism surveys (R=100-300) will be performed with various depths ($m_{AB} \sim 20-25$) and sky coverage (100 to 2 square degrees) over the 1350-2700Å band. We will use the measured UV properties of local galaxies, along with corollary observations, to calibrate the UV-global star formation rate relationship in galaxies. We will apply this calibration to distant galaxies discovered in the deep imaging and spectroscopic surveys to map the history of star formation in the universe over the redshift range zero to two. The GALEX mission will include an Associate Investigator program for primary observations and supporting data analysis. This will support a wide variety of investigations made possible by the first UV sky survey.

2.2. GALEX Surveys

GALEX will produce a statistically powerful database of UV images and spectra of nearby and distant galaxies. Using UV properties, supplemented by other wavelengths, GALEX will derive global parameters for each galaxy (star formation rate, extinction, initial mass function (IMF), starburst parameters) vs. redshift, characterize their relationship to galaxy properties (luminosity, type, metallicity, neighborhood, gas supply) and their evolution by comparing statistical distributions of these parameters to cosmological models of the history of galaxies and QSOs. GALEX is a high-priority Origins and SEU mission, tracing the origins of the majority of stars, metals, and many galaxies and galaxy disks, providing a framework for understanding HST and NGST rest UV from high redshift galaxies, and understanding the drivers of galaxy and QSO evolution. Many UV objects HST must study in preparation for NGST will be discovered by GALEX.

Imaging Surveys GALEX will perform five imaging surveys in a Far UV band (1350-1800Å) and Near UV band (1800-3000Å) with 6-8 arcsecond resolution (80% encircled energy) and 1 arcsecond astrometry.

AIS: An All-sky Survey to 22 m_{AB}, netting ~10,000 galaxies within 70 Mpc and an unbiased local calibration of UV galaxy morphology, SFR, and extinction.

MIS: A Medium Imaging Survey over 1000 square degrees to 23 m_{AB} to provide data on galaxies at intermediate distances and luminosities.

DIS: A Deep Imaging Survey over 80 square degrees to 25 m_{AB} to provide photometric redshifts, extinction and SFR for faint and distant galaxies. DIS regions will overlap SIRTF Legacy SWIRE fields.

UDIS: An Ultra-deep Imaging Survey over 4 square degrees to 26 m_{AB} to provide photometric redshifts, extinction and SFR for the faintest and most distant galaxies.

NGS: Nearby Galaxy Survey of 150 nearby galaxies with exposures of 1-2 orbits per galaxy.

Spectroscopic Surveys GALEX will perform three overlapping slitless-grism Spectroscopic Surveys over the 1350-3000Åband with R$\sim$100-200, resulting in greater than 100,000 galaxies with redshifts ($0<z<2$), extinction, and SFR.

WSS: A Wide-field Spectroscopic Survey to 20-22 m_{AB} over 80 square degrees to calibrate the global UV/SFR/Extinction relations and find the rarest and most luminous star-forming galaxies. WSS will overlap DIS fields.

MSS: A Medium-deep Spectroscopic Survey to 22-24 m_{AB} over 8 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.

Associate Investigator Program GALEX will have an Associate Investigator (AI) Program to complement its baseline mission. Associate Investigators may propose to analyze archival data and/or perform dedicated observations with the GALEX satellite. A period of four months has been set aside in the nominal 28 month mission for dedicated AI observations. NASA has earmarked funding for 2004 and 2005 to support AI's. AI's will be expected to work closely with the GALEX Project. Data products provided to AI's will be standard pipeline products and ultimately included in the GALEX archive at MAST.

2.3. Data Acquisition and Access Overview

GALEX will be launched into low-earth orbit (690 km altitude, 29 deg inclination, 96 minute orbital period). After a one month in-orbit checkout period, GALEX will begin nominal operations. The eight surveys listed in Table 1 will be performed concurrently for the first 28 months. During the last 8 months 50% of the mission time will be devoted to an Associate Investigator Program.

Low-background requirements limit science observations to orbital night (*eclipse*). On the day side of each 96 minute orbit, the satellite will remain with the solar panels pointed toward the sun. As the satellite enters twilight, it will slew to one of the survey *targets*. The imaging window or grism will be selected depending on whether the observing *plan* requires imaging or spectroscopic data. If the plan is spectroscopic, the grism rotation will also be selected. During a typical orbit, the GALEX detectors are ramped to their nominal high voltage

Table 1. GALEX Mission Summary

Survey	Area [deg^2]	Length [Month]	Expos [ksec]	Mag. Lim [m_{AB}]	# Gals	Volume [Gpc^3]	<z
All-sky (AIS)	10,000	4	0.1	20.5	10^7	1.5	0.2
Wide Spect (WSS)	80	4	40	20	10^{4-5}	0.03	0.15
Nearby Galaxies (NGS)	—	0.5	2	$27.5/''^2$	—	100	—
Medium Imaging (MIS)	1000	2	400	23	3×10^6	$\sim$1	0.6
Medium Spect (MSS)	8	2	400	21.5-23.5	10^{4-5}	0.03	0.5
Deep Spect (DSS)	2	4	2000	22.5-24.5	10^{4-5}	0.05	0.9
Deep Imaging (DIS)	80	4	40	25	10^7	1.0	0.85
Ultra-Deep Imaging (UDIS)	4	1	200	26	3×10^5	0.05	0.9

at night entry and ramped down to a safe low state prior to night exit. GALEX detectors are also ramped to safe levels during South Atlantic Anomaly passages, and during scans over bright stars during the All-sky Survey. Bright objects such as the sun, moon, earth limb and bright planets are avoided during observation intervals.

During eclipse segments, GALEX collects time-tagged photon position data from its detectors. To carry out observations the spacecraft attitude will be controlled in one of two patterns, a 1 arcminute *spiral dither* for deep targets, or a $22.5^\circ \times 2.5^\circ$ zigzag *scan* across the sky at $\sim 200''$/sec for all-sky survey observations. Since celestial sources will thus move on the detector, the pipeline software will reposition the photons to common sky coordinates and produce images of sky *tiles.* For some plans, a single *visit* will be insufficient to build up the requisite signal-to-noise, so a series of integrations during new visits will build up the signal of direct and grism images.

The GALEX instrument stores science photon and housekeeping data on the spacecraft solid-state recorder. The 5 GB of science data collected each day will require four 25 Mbps X-band downlink contacts to transmit to the ground for processing. Up to four times per day the SSR is dumped via the X-band transmitter to a ground station in Hawaii or Perth, Australia, operated by Universal Space Networks (USN). Real-time satellite health and safety monitoring is performed by the Mission Operations Center (MOC) in Dulles, Virginia, during the ground pass. Science telemetry is shipped by ground network to the Science Operations Center at Caltech, with a latency of 4 hours for housekeeping and 48 hours for photon data. Science data will be processed at Caltech to produce images, object catalogs, and extracted spectra. Catalogs and spectra will be delivered to the Multi Mission Archive at Space Telescope/Space Telescope Science Institute to be archived in a public database developed with oversight by Johns Hopkins University. All users will have equal and unrestricted access to the public archive data.

3. Science Instrumentation

The GALEX mission is performed with a wide-field (1.2 degree) UV-optimized instrument consisting of a 50 cm modified Ritchey-Chrtian telescope, a selectable imaging window or grism, a dichroic beam splitter and corrector, a far ultraviolet and near ultraviolet sealed tube microchannel plate detector, and support electronics. The instrument is coupled to a Orbital Corporation spacecraft that is three-axis stabilized,

GALEX can conduct either imaging (direct) or spectroscopy (grism) with simulataneous data collection in two ultraviolet bands: FUV and NUV. Telescope astigmatism is corrected for by a low power fused silica aspheric window in the converging beam. This aspheric window bears a multilayer dichroic coating to separate the FUV (reflected) and NUV (transmitted) light. A CaF_2 grism ahead of the aspheric corrector provides slitless spectroscopy over the whole Galex FOV. Imaging is performed by exchanging the grism with a low power plano-convex CaF_2 imaging window. These two components are mounted on a rotating wheel that also provides an opaque position.

Slitless spectroscopy produces numerous overlapping object spectra and multiple orders. For this reason, the grism is designed to be rotated over 1000 separate position angles. All spectroscopic surveys are obtained with a new position angle for each orbit integration. The deep spectroscopic survey will utilize 1000 distinct position angles. Satellite roll, which may also be used for this purpose, is often otherwise constrained.

The GALEX detector system is composed of two large format, 65-mm microchannel plate intensified, delay line readout, sealed tube detectors and associated electronics and were fabricated at UC Berkeley, Battel Engineering, and Southwest Research. Each detector has its own entirely independent set of electronics.

The attitude and control system (ACS) is three-axis stabilized. The ACS provides sun pointing on the day side, slewing to a science target during a 6 minute twilight scan, absolute pointing accuracy of 5 arcminutes, relative pointing errors of 0.3 arcseconds (rss) over 10 second windows, spiral dither and two-axis scan modes.

3.1. Data Acquisition

The GALEX detectors generate 40-bit photon data words which contain coarse (3-bit/axis) and fine (12-bit/axis) X & Y position data, as well as 5 bits each of photon-event pulse-height and photon-event clock-phase information used for performing ex-post facto *rectification* of the digitized photon position. Position digitization uses $\sim 15\mu$m pixels. Periodic detector electronic stim pulse data collected during all nominal science data collection modes is also contained within the science photon data stream. Electronic stim data is used for calibration of detector electronics and measurement of photon processing dead-time, necessary for recovering accurate photometry from the GALEX measurements.

Depending on the instrument data compression setting, an additional 8-bit fine timing word may be added to the photon event word by the DPU, providing timing information to the nearest 20 μs (vs. 5 ms resolution without the extra

Table 2. Instrument Design and Performance Summary

Telescope Aperture	50 cm	
Optical Design	Modified Ritchey-Chrtien with 4 channels: FUV & NUV Imaging FUV & NUV Spectroscopy	
Field of View	1.2 degrees, circular	
Focal Length	3 m	
Telescope coatings	Al+MgF_2	
Imaging/Grism Modes	Optics wheel with (1) CaF_2 Imaging window (2) CaF_2 transmission grism (3) Opaque position	
Grism Rotation	Selectable with a resolution of 0.03 degrees.	
Dichroic/Corrector	Aspheric astigmatism corrector	
Detector	Sealed-tube Z-stack microchannel plate	
Detector Anode	Crossed delay-line	
	FUV Channel	**NUV Channel**
Band	1350-1750Å	1750-2800Å
Beam path	Reflected from dichroic	Transmitted through dichroic
Filters	Blue edge filter	Red block filter/Fold mirror
Detector Window	MgF_2	Fused Silica
Detector Photocathode	CsI, opaque	CsTe, semitransparent
Detector peak QE	12%	8%
Detector max. local countrate	~100 c/s	~100 c/s
System angular resolution		
80% EE diam	6.0 arcsec	8.0 arcsec
FWHM	4.0 arcsec	5.6 arcsec
Spectral Resolution	250-300	80-150
Imaging Effective Area	25 cm^2	44 cm^2
Spectroscopy Effective Area	20 cm^2	39 cm^2

bits). Typical predicted photon rates are 5 kcps (FUV) and 25 kcps (NUV). Maximum acceptable photon rate is 100 kcps on each detector.

The DPU takes science photon data, housekeeping telemetry, and memory dumps, packetizes them in CCSDS format, and writes them to the solid state recorder. The DPU stops with an error in telemetry if the SSR fills before data is downlinked to a ground station.

Data packeting exists at three levels:

1) a variable-sized photon block containing all the data for a single 5 ms interval

2) a variable-sized source packet containing up to 1042 bytes of photon data (a potentially non-integral number of photon blocks), one second's worth of housekeeping telemetry or some amount of memory dump data or fill

3) a one-megabit Instrument Record Block, each of which starts with a sync word, which contains a number of source packets.

During ground contact periods, when the GALEX spacecraft transmits real-time, playback, and science data together over a single physical channel, the data types are distinguished by virtual channel identifiers (VCID). The different virtual channels are listed in table 3.

Table 3. GALEX Satellite Virtual Channel Description

Virtual Channel ID	Type of Data	Source
VC 0	Real-time	Real-Time Critical Housekeeping Telemetry
VC 1	Real-time	Real-Time Normal Housekeeping Telemetry
VC 18	Playback	SSR Playback Critical and Normal H/K TLM
VC 32	Playback	SSR Playback Science Data
VC 63	Fill	VCDU Fill Data

4. GALEX End-to-End Data Flow

4.1. Overview

During regular operations, the GALEX satellite will store science data in an on-board solid-state recorder. This data will be transmitted to the Universal Space Network ground stations.

The GALEX raw telemetry products are those files delivered by Universal Space Networks to the Science and Mission operations centers. The SSR Playback Housekeeping and Science Data (VC18, 32) will be backed up onto portable media at the Operations Centers. One off-site copy of the raw data will be stored at the Space Telescope Science Institute. At the conclusion of the GALEX nominal mission, 3 years after launch, the full set of raw data will be delivered to the NSSDC for deep archiving together with project documentation describing the format and contents.

Raw telemetry will be converted into science data products at the Science Operations Center. These higher level products will be distributed to the astronomical community by the GALEX support staff at the Multi-Mission Archive at Space Telescope.

4.2. Science and Mission Operations Center

Mission Operations will be performed at Orbital Science Corporation Dulles Mission Operations Center (MOC). Science observations for the GALEX mission are planned at the Science Operations Center at Caltech in Pasadena, CA. Once per week, an observation description file containing a time-ordered sequence of pointing and instrument setting commands is sent to the Mission Operations Center. GALEX science mission planning software is designed to schedule the science surveys as efficiently as possible while ensuring that no operational or scientific observing constraints are violated.

Ground contacts will occur four times per day over the Universal Space Networks (USN) Perth and Hawaii stations. Satellite and instrument housekeeping will be monitored during ground contacts. Real time commanding will be used only during In-Orbit Checkout (IOC) and during critical command sequences.

USN will process the telemetry data as follows:

- Real-time critical housekeeping telemetry (VC0) shall be sent to the MOC as received.
- Real-time normal housekeeping telemetry (VC1) shall be sent to the MOC as received.
- Recorded Normal/Critical Housekeeping Telemetry (VC 18) shall be pushed to the MOC and placed on the MOC FTP server by USN. These files shall also be pushed to the SOC and placed on the SOC FTP server by USN.
- SSR Playback Science Data (VC32) shall be pushed to the SOC and placed on the SOC FTP server by USN.
- Fill frames (VC63) shall be discarded by the USN CGN as they are received.

The GALEX data analysis pipeline operated at the Science Operations Center receives the time-tagged photon lists, instrument/SC housekeeping and satellite aspect information within two days of the ground contact. From these data sets, the pipeline and generates images, spectra and source catalogs. The first pipeline module corrects the photon positions for detector and optical distortions and uses a maximum-entropy algorithm to calculate an optimal aspect solution based on the time-tagged photon data. A photometric module accumulates the photons into count and intensity maps and extracts sources from images. A spectroscopic module uses image source catalog inputs to extract spectra of these sources from the multiple slitless grism observations.

4.3. Data Products and Access Overview

GALEX data will be archived and distributed by MAST in a system that parallels that developed for the SDSS (Sloan survey) at Fermilab. Processed observation-level image and spectroscopic data will be grouped into *packages* and ingested into a relational database. Periodically, recalibrated data may be reingested into the database. In such cases the latest version of a dataset or catalog will always be the default for retrieval by users. Datasets will be tagged with version numbers so that uders can identify the processing run.

The science data pipeline will generate calibrated images, spectra and source catalogs of the astronomical objects detected by the GALEX instrument. Merged object catalogs will contain two-bands of photometric and astrometric measurements of detected sources. Positions determined from images will be used to reference the wavelength system for the slitless grism spectra. Spectra catalogs will contain spectra combined over both bands. In general, spectra will be only point and marginally resolved source extractions. However some extended object spectra may be analyzed by the pipeline and/or special analysis modules.

Initial catalogs, meta- and diagnostic data will be stored at the Science Operations Center in an "proto-science" archive associated with the data pipeline at the Science Operations Center. The pipeline data will be validated by the GALEX Science Operations and Data Analysis (SODA) team.

Microsoft SQLServer will be used as the database management system for the GALEX science and proto-science archives. It is expected that the SOC proto-science archive will be very similar or identical in form to the archive at MAST. Furthermore, MAST will be responsible for exporting to JHU a copy of its database, where members of the GALEX science team will evaluate and optimize the archive design MAST using calibrated pipeline files.

Once validated, all data will be delivered from the Caltech GALEX SODA to MAST as Unix tar files. All images and tables contained in these tar files will be in FITS format. SODA will provide data to MAST in two phased deliveries targeted around three public data release dates: a very early small public release (DR-0), a preliminary data release containing 10% of the mission data (DR-1) and a subsequent "complete" data release (DR-2). If more than two data releases are required SODA will label these releases DR1, DR2, ...DRn. The automated outputs of the GALEX data pipeline will provide the primary data set for the archive database tables. Supplementary data will also be obtained from science operations planning files, calibration data, corollary data sets and tables and/or files generated *ex post facto* for archival purposes. All of these datasets, tables and images will be in FITS format.

Views One of the benefits of building an archive in a relational database environment is that one can make use of *views* to facilitate rapid responses to queries. The MAST public archive will provide a set of predetermined views for the benefit of the astronomical community.

A *view* is a script written in SQL that returns a virtual table of information collated from one or more Database Tables. A *view* executes certain commonly occurring queries in memory as an on-the-fly set of instructions rather than storing a bulky, special-purpose table that, along with other such tables, could occupy large amounts of disk space. Examples of queries might be a list of all neighoring objects within a given radius for a particular type of object, a list of a certain type of object imaged with either (or both) detectors, or a list of GALEX-measured redshifts of galaxies.

New *views* will be created as the need arises. Because they are predefined queries on the Database Tables, a *view* does not have to be re-created after a new data ingest.

Constants and Functions *Functions* serve the same purpose as in other software applications, to facilitate the computation of repetitive opeerations in a separate program module, and are optimized for rapid access to the Database Tables. A *function* might be used to find the URL of an object from other informational resources (e.g. entries for the object in other databases or to papers in the literature), determining the nearest neighbor for a given object, or selecting a type of object in a specified area of the sky. MAST will provide a predetermined set of functions to the astronomical community for

Likewise, *constants* will be stored in the Database and may be utilized by *views* or *functions* or downloaded by users for customized queries. The *constants* used might include universal constants (e.g., the speed of light in a vacuum or the wavelength of the Lyman break) or mission or instrumental constants (UV bandpass properties, orbital period).

Sky coordinate schemes Three types of sky coordinates will be used in the MAST GALEX archive: right ascension and declination, cosine angles x, y, and z on a unit sphere, and HTM identifiers.

4.4. Data Archiving and Distribution

As described in previous sections, MAST will archive and distribute high-level GALEX pipeline-processed science products to the astronomincal community. The baseline products are summarized in the Table 4. These will be delivered in three *"DR-0"*, *"DR-1"*, *"DR-2"* releases. The *DR-0* products will be scheduled for release approximately 3 months after the end of the In-Orbit Checkout phase of the mission. The *DR-1* products will be scheduled for public release approximately fifteen (15) months after the end of the Orbital Verification phase of the mission and will contain roughly 10% of the total volume contained in *DR-2*. The *"DR-2"* delivery date is estimated to be three years after launch, roughly 8 months after completion of the AIS, imaging and spectroscopic surveys. All data products will be delivered in FITS format.

Table 4. GALEX Data Archive Products

Product	Contents	Medium	DR-1 Volume	DR-2 Volume
Images	4096×4096" 2 images/orbit	Tape/DVD	0.2 TB	2 TB
SkyMap	1.5×1.5"-pixels	Tape/DVD 2 images/orbit	0.25 TB	2.6 TB
Point Source Cat	10^7 sources	Web	2 GB	20 GB
Extended Source Cat	10^5 sources	Web	2 GB	2 GB
Spectrum Cat	10^5 sources	Web	2 GB	20 GB
Cross-ID Cat	10^7 sources	Web	2 GB	20 GB

Disposition of data Data will be delivered at discrete intervals to MAST at dates posted on GALEX Project web pages. The delivery will be carried out on a mutally agreed upon media/protocols such as DAT tapes, pluggable hard drives, or ftp transfers. Data transfers will occur every three months.

Ingest and Reingest MAST will ingest GALEX data products on a dedicated storage medium into the Database described above. The Database will exist behind a secure firewall on the MAST/GALEX computer.

Reingest is defined as the process of ingesting GALEX data files into the MAST archive that supercede older files generated by a previous version of

SODA's pipeline processing code. Updated files, such as history logs or accumulated ("stacked") data resulting from new program visits and revised processings due to conceivable misconfigurations of pipeline software modules, are not included in this definition.

Old versions will be maintained on backup media at the Science Operations Center and will be retrievable for archival or reference purposes.

Reingests will occur at discrete infrequent intervals, as mutually agreed upon between CIT and MAST. The community will be notified of reingests through What's New pages under the MAST/GALEX home page.

4.5. Archival Data Volume

The raw data files from the nominal GALEX mission will require 5 TB storage capacity. The catalogs in the GALEX public archive will require 100-200 GB. The associated images for the GALEX public archive will require 5 TB storage.

4.6. Archive Data Access

Researchers will access the STScI/MAST GALEX archive through a web interface managed by cgi-based scripts similar to those developed for other MAST missions. Its entry point is located at http://archive.stsci.edu/galex.html. This entry point will also lead users to the image and spectral catalogs, the all sky map (FUV, NUV), and other major data products contained in the MAST database. The return page from a query will contain links allowing users to download data products such as stacked FITS images or to browse GIF spectra of selected objects. A second web entry point, utilizing Active Server Page (ASP) technology and the *Microsoft .NET* environment, will be developed early in the GALEX mission. This will provide still increased functionality and will permit the construction of a GALEX web service that permits convenient cross-correlations with other major astronomical surveys and and ultimately integrated within a future NVO environment.

Help/Support Help pages will be written by MAST to facilitate the use of interface query pages, including meanings of mission-specific fields, examples of syntax for field entries, and links to sample queries. Specific pages will be maintained that define Database-specific *views*, *functions,* and *constants,* which are of use in building SQL queries in the interface query box. It is expected that MAST will maintain a helpdesk and will field questions to MAST personnel regarding data access problems and to Project members for information on the scientific or technical content of the files not discussed in the help pages. Links will also be provided in the interfaces to any user or data manuals, guides, or related documentation written by the Project. Updates will be provided on the types of *views* for queries and specific user functions. It is expected that the GALEX project will provide scientific and technical assistance to MAST archive for the duration that the GALEX Science Operations Center is actively funded. GALEX is not providing staff or funding to STScI to make the data deliveries to the public.

The STScI archive hot seat (archive@stsci.edu) is likely to be the first recourse for users with questions about GALEX data. Questions relating to access and retrival of data will be handled by MAST staff. Questions concerning the data *per se* or its analysis should be forwarded to the GALEX Project. Responses by the GALEX team should be copied back to the STScI help desk, which will track all queries and responses in its database.

Proprietary rights All GALEX data products will be available to all users after they have been ingested into the STScI GALEX archive on or after the specified data release dates.

1. Appendix: Acronyms

AIP Associate Investigator Program

AIS All-sky Imaging Survey

ASP - Javascript Active Server Page, a new technology for data access and browsing

CCSDS - Consultive Committee for Space Data Systems

CSV - comma-separated value

HTM - hierarchial triangular mesh (recursive sky-partitioning system); generally coordinates are specified at "level 20" in the HTM system, giving a precision of < 0.1 arcsec

MAST - MultiMission Archive at Space Telescope Science Institute

MOC - Mission Operations Center (Caltech)

SOC - Science Operations Center (Caltech)

SODA - GALEX Science Operations and Data Analysis Center (Caltech)

USN Universal Space Network

```
Programs:

AIS All-sky Imaging Survey

MIS Medium Imaging Survey

DIS Deep Imaging Survey

UDIS Ultra-deep Imaging Survey

NGS Nearby Galaxy Survey

MSS Medium Spectroscopic Survey

DSS Deep Spectroscopic Survey

API Associate Investigator Program Imaging

APS Associate Investigator Program Spectrscopy
```

`CAI` Calibration Imaging

`CAO` Calibration Opaque

`CAS` Calibration Spectroscopy

`WSS` Wide Spectroscopic Survey

2. Appendix: Definition of GALEX-Specific Terms

The following are planning terms used by GALEX:

- *Dither:* A controlled motion of the satellite to move the telescope boresite in a tight, slow spiral pattern that moves outward to ($\sim 1.5'$) diameter across the sky.
- *Eclipse:* Time interval during which the Sun is occulted by the Earth during a particular orbit of the spacecraft
- *Observation:* The acquisition of photon data from a region of the sky during a single orbital night (eclipse).
- *ObsFile:* Observation commands generated by the SOC to be sent to the spacecraft
- *Plan:* The requirements, constraints and priority for a series of observations of a single target. Requirements might include minimum exposure time and predecessor targets. Constraints may include start and end dates and South Atlantic Anomaly avoidance flags. Priority is used to create a hierarchy of plan based on a simple rank order scheme.
- *Programs:* A collection of plans designed to accomplish a particular scientific goal. This can include survey programs, calibration programs and targeted observation programs.
- *Region:* A pre-defined area on the sky where one or more *targets* (see list below) are clustered. A region is used for planning purposes.
- *Scan:* A single motion of the satellite at single commanded rate about the X and/or Y axes where the Z axis is aligned with the instrument telescope boresite. Scans move the boresite axis of the telescope across the sky.
- *Segment:* A time period during an eclipse when the instrument configuration is not changed and valid photon data is expected
- *Target:* An area of sky to be observed by the GALEX telescope as described by a series of attitude control *dither* and/or *scan* maneuvers of the satellite. A target may have an arbitrary shape. Targets may overlap one another.

The following is a list of terms specifically related to pipeline image processing.

- *Dose:* Number of detected photon counts in detector coordinates
- *ImgRun:* Image generation parameters
- *ImgVisits:* Mapping between visits and image processing runs
- *PhotoExtract:* Extraction Run information
- *PhotoObj:* Extracted objects from direct images
- *PhotoTruthCat (simulation only):* Contains information about the files containing truth objects
- *PhotoTruthMatch (simulation only):* Matches extracted objects to simulated truth objects
- *Raw 6 format:* Standard 6-byte photon format for GALEX data.
- *Tile:* An area of sky for which the pipeline has generated an image using GALEX photon data. A *tile* may have an arbitrary shape, but in general tiles will be rectangular with north in the +Y direction. Note that there can be primary, secondary and all-sky survey *tiles,* defined as follows:
  - *Primary Tile:* A *tile* whose image center coordinate (RA, DEC J2000) is matched to the center of a target.
  - *Secondary Tile:* A *tile* whose image center coordinate (RA, DEC J2000) is not matced to the center of a target.
  - *All-sky survey Tile:* A *tile* whose image center coordinate (RA, DEC J2000) and size is specifically selected for the all-sky survey.
- *Visit:* The period during a single eclipse that the GALEX field of view actually overlapped a particular *tile*
- *VisitData:* Processed data from a single visit

The following is a list of terms specifically related to pipeline spectroscopy processing.

- *ELRedshift:* Contains data for the emission line redshifts
- *SpecExtract:* Data describing each spectral extraction (extraction type may be optimal (default) or simple boxcar)
- *SpecFlux:* Spectrum consisting of wavelengths, fluxes, & error tables
- *SpecLine:* Contains information about a single spectral line
- *SpecObj:* Table summarizing spectroscopic parameters for objects observed in spectroscopic surveys
- *SpecStrip:* Spectral strip characteristics
- *XCRedshift:* Table of cross correlation redshifts