

Chandra Source Catalog

Archive and Catalog

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Outline

- Architecture
- Catalog contents
- Versioning, referencing, and tracking
- User interface
- Virtual Observatory compatibility

Architecture

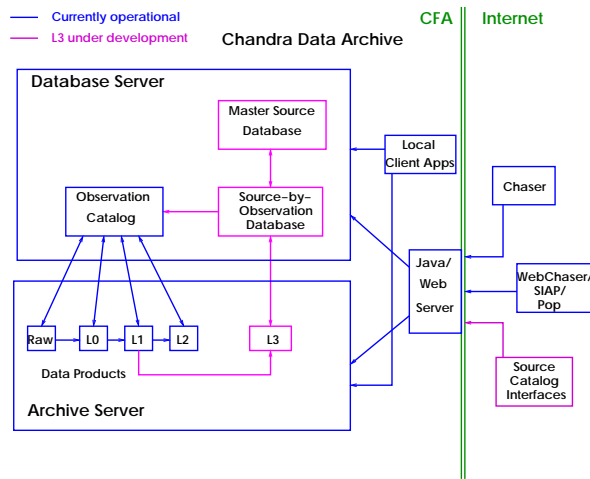
- Catalog Databases:
 - Observation
 - Source by observation
 - Master source list
- Data Objects:
Tagged with version info and associated source Id; FITS
 - Event list
 - Image
 - Spectrum
 - Light curve
 - Region

2006-02-09

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3

Archive Context

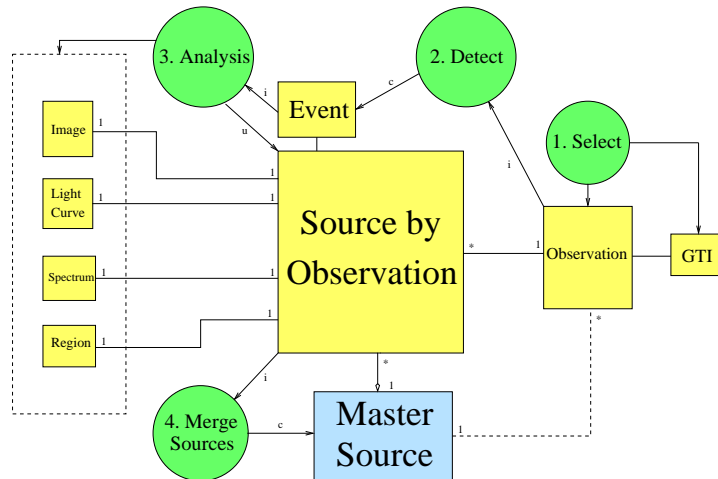


2006-02-09

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4

Archive Thread



2006-02-09

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5

Contents of Catalog Databases

- Observation
- Source by observation
- Master source list

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6

Observation Database

- Version info of associated data objects
- Parameters:
 - Position
 - Time
 - Exposure time
 - Processing date
 - Instrument
 - Etc.

Source-by-Observation Database (1)

- Version info of associated data objects
- Observational parameters:
 - Chip info
 - Corrected exposure time
- Spatial parameters:
 - Position
 - PSF parameters
 - Size
 - Errors

Source-by-Observation Database (2)

- Spectral parameters:
 - Flux density
 - Simple model fit parameters
 - Errors
- Temporal parameters:
 - Variability index

Master Source Database

- Roughly the same, except for:
 - No PSF information
 - Added information in what specific instrument configurations the source has been observed
 - Hardness ratios (colors) and associated errors

Master Source Database – Spatial Parameters

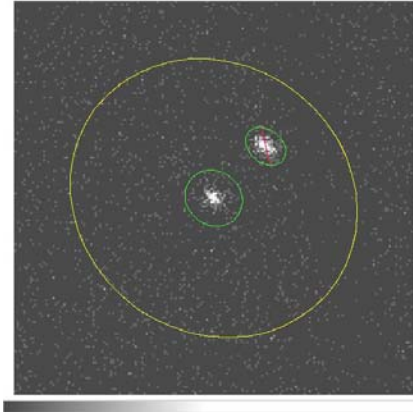
MASTER			
Name	Description	Type	Unit
name	CXO Jhhmmss.s+ddmmss	char[20]	
ra	Right Ascension	double	deg
dec	Declination	double	deg
err_ellipse_r0	Position error ellipse parameters	double	arcsec
err_ellipse_r1	Position error ellipse parameters	double	arcsec
err_ellipse_ang	Position error ellipse parameters	double	deg
gal_b	Galactic coords	double	deg
gal_l	Galactic coords	double	deg
major_axis	Major axis of source ellipsoid (deconvolved)	double	deg
major_err	Error on major axis	double	deg
minor_axis	Minor axis of source ellipsoid (deconvolved)	double	deg
minor_err	Error on minor axis	double	deg
pos_angle	Position angle of source ellipsoid (deconvolved)	double	deg
pos_angle_err	Error on position angle	double	deg

Catalog Data Objects (1)

- Why data objects?
 - The data subsets that the database information is derived from
 - Allow alternative parameter extraction by users
- Why these data objects?
 - Photon event lists contain all (4-D) information
 - The other objects provide projections onto spatial, temporal, spectral coordinates; and include calibration objects

Catalog Data Objects (4)

- Regions
 - Description of the source and background regions that were used and are recommended



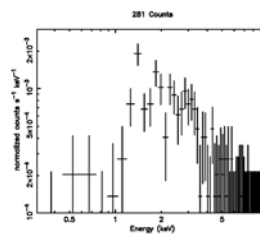
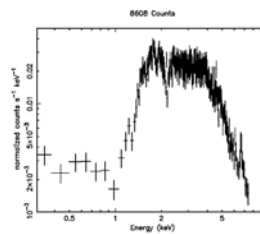
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15

Catalog Data Objects (5)

- Spectrum
 - Source and background spectrum
 - Errors
 - ARF, RMF links
- Shown are two spectra with 8700 and 280 counts, respectively



2006-02-09

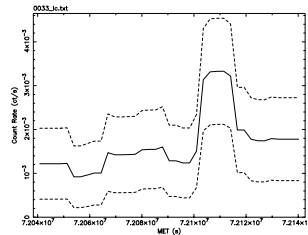
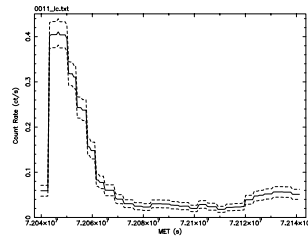
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16

Catalog Data Objects (6)

- Light curve
 - Time and counts in appropriate binning
 - Errors
 - ACIS: in 4 bands

– Shown are two light curves with 8700 and 170 counts, respectively
the three curves in each panel are the light curve and $\pm 3\sigma$



2006-02-09

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17

Versioning (1)

- New records for sources-by-observation are continuously added as observations become public
- Source-by-observation records are updated as observations are reprocessed
- New master source list records are created, or existing ones updated, as the above transactions happen
- Consequently, the contents of the catalog tables and data objects change (improve) daily

2006-02-09

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18

Versioning (2)

- User are expected in general to want to download the most recent information
- Requirement: it shall be possible to extract information from the catalog in its current state as well as in the state it was in at any time in the past
- A complete history of catalog updates will be kept to satisfy this requirement – e.g., by retaining each version of each record, with the dates it was created and superseded
- Certain significant dates will be aliased as virtual releases (“snapshots”) to aid the user community

Referencing and Tracking (1)

- Source in the Master List will be named using the registered acronym CXO, following the conventions of the IAU Nomenclature Clearinghouse:
CXO J123456.8+123456
- References between Sources-by-Observation and Master List records will need to be retained in both directions
- There is a major complication:
 - Multiple sources

Referencing and Tracking (2)

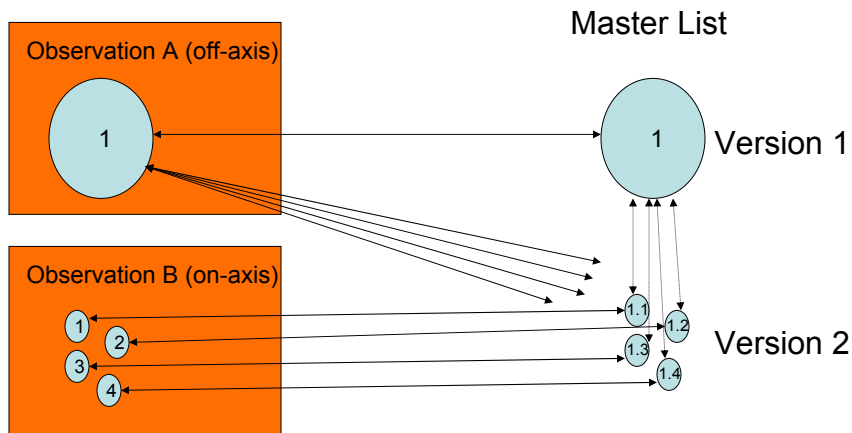
- In particular because of the large variation in spatial resolution across the field, the links between sources in a single observation and associated master list sources will not always be one-to-one
- The same is true for different versions of the same source in the master list
- Forward and backward referencing needs to be supported
- This requires a sophisticated multi-level referencing mechanism

2006-02-09

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21

Referencing and Tracking (3)



2006-02-09

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22

Interlude: the Virtual Observatory

- Virtual Observatory (VO):
 - Uniform data access to, and interoperability between, astronomical data depositories
- International: IVOA
- National: NVO
- Substantive involvement of L3 team
- Standard protocols and applications:
 - SIAP, SSAP, ADQL, registry, VOTable
 - Open SkyQuery, DataScope, VOPlot, TOPCAT

User (Web) Database Interface (1)

- Examples of existing interfaces to heed:
 - Vizier
 - NED
 - Open SkyQuery
 - Mirage, TOPCAT
- Output formats:
 - HTML
 - ASCII
 - Tab-delimited ASCII
 - VOTable
 - Other XML?

User Database Interface (2)

- Access:
 - To Master List as well as sources-by-observation
 - Catalog state at any time in the past
- Links:
 - Bibliography
 - SIMBAD
 - NED
 - DataScope
 - VOPlot, TOPCAT
 - ...

User Database Interface (3)

- Principles to bear in mind:
 - Primary user interface will be web-based
 - Web-GUI will be the equivalent of SQL (or ADQL) query
 - User-friendliness is the guiding principle for the web-GUI
 - Will allow selection from uploaded file and equivalent command-line SQL-like querying
 - Technology (and VO standards) will continue to evolve – consequently, these interfaces will evolve over time
 - Full logging of submitted queries – for traceability as well as analysis

Query Options (1)

- Simple *Select-From-Where-Order* interface:
 - `select ra, dec, flux_2_10, flux_2_10_err from master_list where gal_b>30 and acis_time>50.0 order by flux_2_10`
 - In a GUI as well as command line interface
- Integrate input from name resolvers
- Virtual columns: allow creation of new columns through arithmetic and conditional expressions involving existing columns:
 - `select ra, dec, flux_2_10, flux_2_10_err, minor_axis/major_axis from master_list where gal_b>30 and major_axis>0.01 order by flux_2_10`

Query Options (2)

- Allow virtual columns to be used in *Where* conditions:
 - `select ra, dec, flux_2_10, flux_2_10_err from master_list where major_axis/major_err>2.0 order by flux_2_10`
- Allow cross-matching against catalogs on the web
- Allow cross-matching against user-provided catalog
- Link sources to full-field views and vice-versa
- Link results to other services (e.g., DataScope)

Query Mock-up

2006-02-09

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29

Query Results Mock-up

Name	RA (h m s)	Dec (d ° ' '')	Flux Density	Flux Density error	Event list	Image	Spectrum	Light curve	DataScope	NED	SIMBAD
CXO J128456.7+128456	12 34 56.7	+12 34 56	14 e-15	3 e-15	click	click	click	click	click	click	click
CXO J234507.8-234506	23 45 07.8	-23 45 06	24 e-15	4 e-15	click	click	click	click	click	click	click
CXO J215432.8+765432	21 54 32.8	+76 54 32	4 e-14	5 e-15	click	click	click	click	click	click	click

2006-02-09

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30

User Interface to Databases and Data Objects (1)

- All data object access will be navigated through source databases
- Two access methods to data objects (1):
 - Through catalog user interface, as virtual columns in the *Select* part of the query (see mock-ups)
 - Bulk retrieval
 - Links in the results table

User Interface to Databases and Data Objects (2)

- Access methods to data objects (2):
 - API to tools and workflows, allowing users to:
 - Construct their own catalogs
 - Do bulk analysis processing on sources
 - Construct sophisticated queries
 - Tools may be:
 - CIAO-based
 - User-provided
 - Virtual Observatory protocols

Virtual Observatory Compatibility

- We are committed to provide compatibility with VO standard interfaces and tools wherever practical
 - Our users do not have to come through VO interfaces, but neither do we want to deny access to VO users
- Note that these protocols are still, and will be for some time, evolving
- Substantial involvement in NVO/IVOA work
- Examples:
 - SIAP for image retrieval
 - ADQL query language
 - DataScope
 - VOPlot
 - SSAP for spectra and light curves
 - Open SkyQuery
 - VOTable
 - TopCat

Open SkyQuery Sample

```
SELECT o.objId, o.ra,  
       o.dec, o.type, t.objId,  
       t.j_m, o.z  
FROM  
  SDSSDR2:PhotoPrimary o,  
  TWOMASS:PhotoPrimary t  
WHERE XMATCH(o, t) < 2.5 AND  
       Region('CIRCLE J2000 16.031 -0.891 30')  
AND  
       (o.z - t.j_m) > 2
```