

CENTER FOR **ASTROPHYSICS**
HARVARD & SMITHSONIAN

Spreading the knowledge of Chandra X-ray data

Francesca Civano

on behalf of the *Chandra* Source Catalog team

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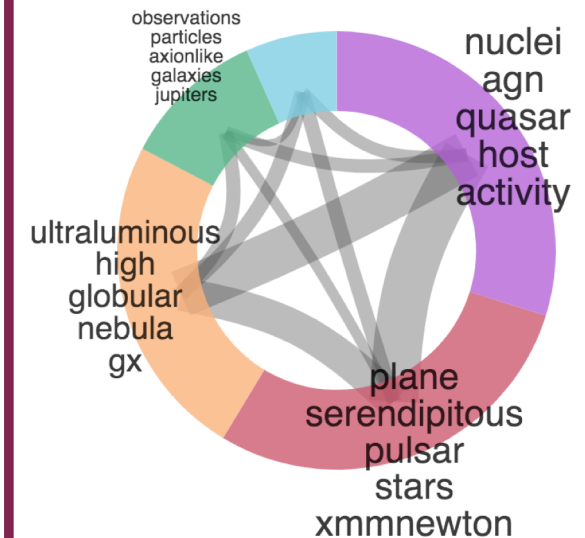
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The Chandra Source Catalog 2.0

- CSC 2.0 was released officially on *2019 Oct 24*
 - Includes observations until end of 2014
 - ~376K unique X-ray sources, ~928K detections
 - ~25TB science-ready FITS data products
 - Hundreds of source properties
- *2020-2021*: Reprocessing the entire *Chandra* mission dataset in part to prepare for the next CSC production
- *Beginning 2022*: Starting production for CSC 2.1 which will include all data from beginning of the mission to ~current

Excellent **broad** CSC impact in the last 2 years:
~100 refereed papers quoting the CSC, ~900 citations, ~28K reads





Catalog Data Access

<http://cxc.cfa.harvard.edu/csc/>

- Quick Search: the CSC **web interface**
- Quick View: the **World Wide Telescope**
- Data access and retrieval: the **CSCview** Application
- Science Analysis threads as Jupyter Notebooks
- Virtual Observatory interfaces
- CIAO command line scripts
 - Search_csc
 - Obsid_search_csc



For a quick search: web search

<http://cda.cfa.harvard.edu/cscweb/index.do>

Chandra X-ray Center

Chandra Source Catalog 2.0 Quick Search

A quick search interface to the [Chandra Source Catalog](#). Full search capabilities are available via the [CSCview application](#).

[Home](#)

Single Cone | Crossmatch

by coordinates

by name

Right Ascension
value in decimal degrees in [0, 360) or equivalent in sexagesimal in HMS or DMS

Declination
value in decimal degrees in [-90, 90] or equivalent in sexagesimal in DMS

Search Radius
1' arcmin value in: [0, 60]

Display
10 Rows

Search



For a quick view: WWT

<https://cxc.cfa.harvard.edu/csc/owwt.html>

CHANDRA SOURCE CATALOG 2.0

Sources: 315880 (100.0%)

Select nearest source

Enter Name or Position:

Optical (DSS)

Show Popular Places

Hide Stack Outlines

Hide CSC 2.0 Sources

Load XMM Sources

Show Milky Way outline

Full screen

Hide banners

Help

Credits

CXC HOME PROPOSER ARCHIVE DATA ANALYSIS INSTRUMENTS & CALIBRATION FOR THE PUBLIC

Source: 2CXO J055033.8-682416

[Copy source name to clipboard](#) [Search nearby: NED or SIMBAD](#) [Zoom to source](#)

α : 5^h 50^m 33.83^s δ : -68° 24' 16.8" (ICRS)

<u>95% confidence position error ellipse</u>	1.29" by 0.56" at 129°
<u>Galactic n_H column density</u>	6.59 × 10 ²⁰ cm ²
<u>Aperture-corrected flux (broad band)</u>	7.964e-16 erg cm ² s ⁻¹
Lower confidence limit	2.172e-16
Upper confidence limit	1.376e-15
<u>Source significance (S/N)</u>	2.61
<u>Hard/Medium band hardness ratio</u>	0.075
Lower confidence limit	-0.3467
Upper confidence limit	0.4329
<u>Medium/Soft band hardness ratio</u>	-0.0412
Lower confidence limit	-0.4029
Upper confidence limit	0.3929
<u>Number of ACIS observations</u>	1
<u>Number of HRC observations</u>	0

Please review the current [caveats](#) for source properties in CSC 2.0.

- 70

SAMP to DS9 and or TOPCAT

The Chandra X-Ray Center (CXC) is operated for NASA by the Smithsonian Astrophysical Observatory, 60 Garden Street, Cambridge, MA 02138 USA. Email: cxchelp@head.cfa.harvard.edu Smithsonian Astrophysical Observatory



For Data Retrieval: CSCView

Demo: <https://www.youtube.com/watch?v=cM91pVcRhH4>

The screenshot shows the CSCView application window. The title bar reads "Chandra Source Catalog: Current Database". The interface is divided into several panels:

- Standard Results:** A tree view on the left containing "Standard Queries" and "Standard Search Criteria".
- Source Properties:** A tree view on the left containing "Master Sources" and "Source Properties" with sub-items like "Source Name", "Source Position", "Galactic Coordinates", "Position Error: Ellipse", "Source Significance", "Source Flags", "Source Extent", "Aperture Photometry", "Spectral Hardness Ratios", "ACIS Hard-Medium (1.2-2.0 keV) Energy Band", "ACIS Hard-Soft (0.5-1.2 keV) Energy Bands", "ACIS Medium-Soft (0.5-1.2 keV) Energy Band", "Model Spectral Fits", "Temporal Variability", and "Observation Summary".
- Select:** A dropdown menu showing "top 1000" and "distinct rows".
- Result Set:** A table with columns "name", "ra", "dec", "err_ellipse_r0", "err_ellipse_r1", "err_ellipse_ang", "conf_flag", "sat_src_flag", "significance", "flux_aper_b", "flux_aper_lolim_b", "flux_aper_hilim_b", "flux_aper_w", "flux_aper_lolim_w", and "flux_aper_hilim_w".
- Sort Order:** A dropdown menu showing "name" and "ascending".
- Search Criteria:** A text input field containing "(significance > 5.0)". A red arrow points from a text box to this field.
- Position Search:** A section with radio buttons for "None", "Cone", and "Crossmatch". Below are fields for "Name: 4C 23.56A", "Resolver: Simbad/NED", "Radius: 30.0", and "arcmin". A red arrow points from a text box to this section.
- Table:** A table at the bottom with columns "Table", "Name", "Datatype", "Units", and "Description".

Annotations in the image:

- A red box with the text "Criteria to search on: ADQL queries" has a red arrow pointing to the "Search Criteria" field.
- A red box with the text "Cone search and cross-match" has a red arrow pointing to the "Position Search" section.

Table	Name	Datatype	Units	Description
Master Sources	err_ellipse_r0	double	arcsec	Major radius of the 95% confidence level position error ellipse
Master Sources	err_ellipse_r1	double	arcsec	Minor radius of the 95% confidence level position error ellipse
Master Sources	err_ellipse_ang	double	deg	Position angle (ref. local true north) of the major axis of the 95% confidence level error ellipse

Search completed



CSC Jupyter Notebooks Tutorials

demo: <https://youtu.be/okjNjkzKq6k>

- Make use of [PyVo](#) to query the CSC 2.0, [CIAO](#) tools to retrieve catalog data products, [astropy](#) to perform cross-matches with other catalogs, and more...
- Examples:
 - For basic data retrieval, cone-searches, cross-matches and access to data products:
https://github.com/juramaga/CSC2_tutorials/blob/main/CDS2021_CSC2_tutorial.ipynb
 - For cumulative sky coverage and sensitivity maps:
https://github.com/juramaga/CSC2_tutorials/blob/main/CSC2_cumulative_sky_coverage.ipynb
- More to come...

Virtual Observatory Interfaces

<https://cxc.cfa.harvard.edu/csc/cli/index.html#vo>

- Cone search
 - Table Access Protocol
 - Simple Image Access Protocol
- Catalog is available in ESASky (as well as Chandra Archival HiPS)
- Can be accessed via TOPCAT
- In progress:
CSC HiPS and MOC

Outreach

- AAS in person presence (last was Jan 2020)
- Virtual AAS presence and webinars
- Talks at CIAO workshops
- Tutorials at Chandra Conferences

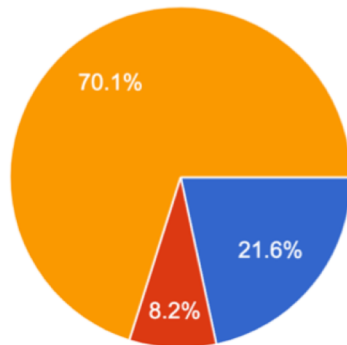


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CSC User Survey

What type of datasets from the catalog are relevant for your research:

134 responses



- Tabulated properties (hardness ratios, variability probabilities, fluxes, etc.)
- Data products (Light curves, spectra, exposure maps, source event files etc.)
- Both

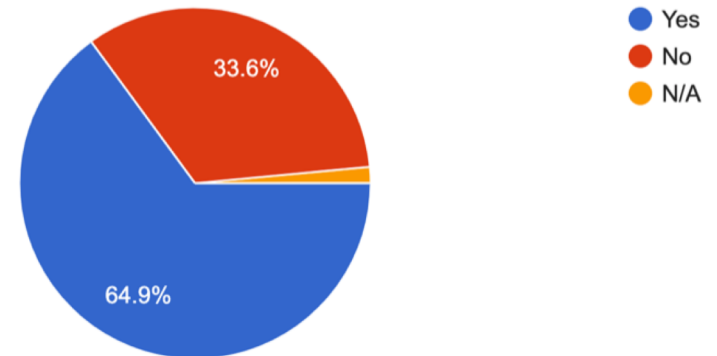
Source properties are mostly used

→ We need to make Data products more **visible**

Growing interest from non X-ray astronomers!
→ What **more** can we serve to them?

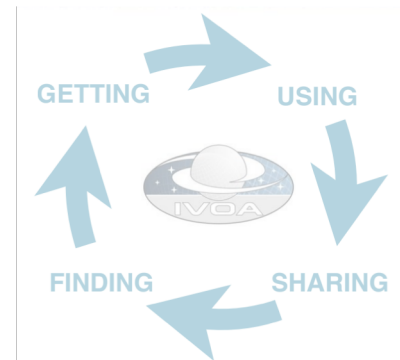
Do you consider yourself mainly an X-ray astronomer?

134 responses



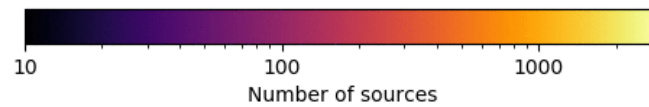
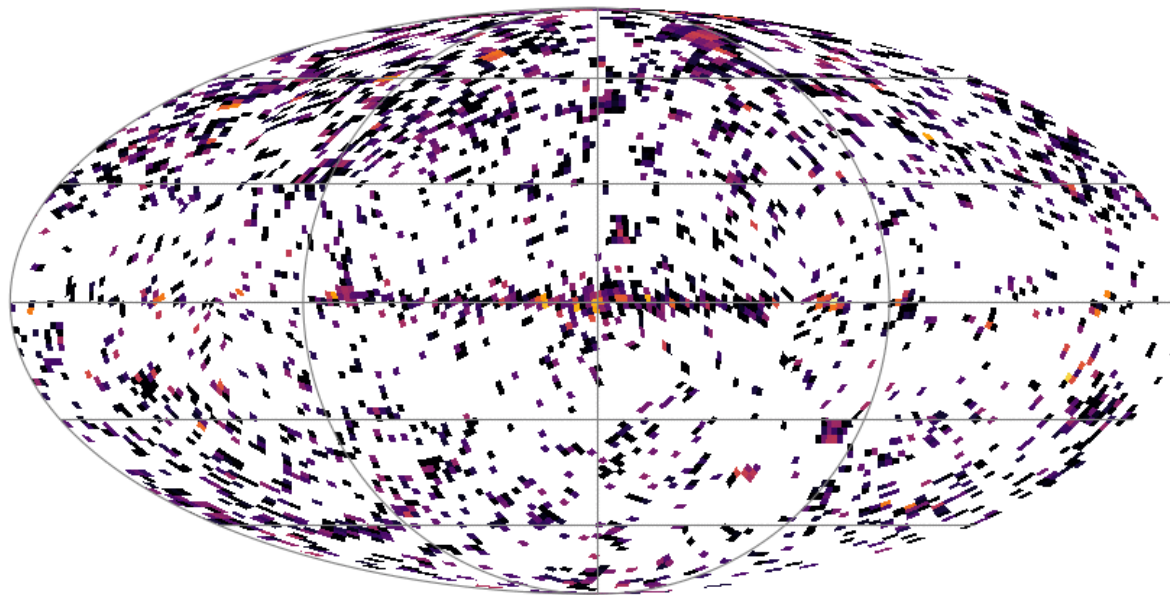
Giving back to IVOA

- Discussed science considerations for X-ray catalog data at May 2021 Data Model workshop:
 - Measurements may have non-symmetric or non-analytic representations of confidence interval (errors), e.g., PDFs, MCMC draws
 - Measurements may be time variable
 - Measurements may depend on assumed properties (such as spectral shape) and have associated ancillary data (such as responses)
 - Measurements may be upper/lower limits



THANKS

CSC 1.1



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