Chandra Source Catalog

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The latest version of the *Chandra* Source Catalog (CSC Release 2.0, or CSC 2.0) includes scientifically useful properties for roughly 316,000 distinct X-ray sources on the sky. These properties were extracted from almost 375,000 source detections included on more than 10,000 *Chandra* ACIS and HRC-I imaging observations that were released publicly through the end of 2014. The sky coverage of CSC 2.0 is approximately 600 deg^2.

Source detection is performed on "stacked" (co-added) observations of the same field to improve detection sensitivity for fields with multiple observations. The use of multiple detection algorithms, graded by a maximum likelihood estimator, yields an on-axis source detection limit of about 5 net counts for exposures < 15 ks (for longer exposures, background becomes increasingly important, effectively raising the net count detection threshold).

Numerous detection properties are evaluated at both the stacked-observation and single-observation levels (see Table 1). Multiple detections of the same source are grouped together where appropriate using a Bayesian blocks algorithm to identify detections with similar multiband aperture photometry photon fluxes, thus improving signal-to-noise (S/N) ratios, even for variable sources. The longest-exposure block is used to populate "best estimate" master source properties for each source on the sky. Multiband limiting sensitivity is computed for the entire sky coverage of the catalog at a resolution of 3.22 arcsec × 3.22 arcsec.

Numeric properties have associated uncertainties, usually independent lower and upper confidence limits, and most properties are evaluated in 5 energy bands for ACIS observations, and a single energy band for HRC-I observations. As a result of this multiplexing, the catalog databases include approximately 1700 columns of information, split across several tables.

In addition to the tabulated source properties, CSC 2.0 also provides roughly 40 different types of science-ready FITS data products (see Table 2). Since these data products are pre-computed by applying all of the appropriate calibration steps (e.g., matching astrometry, merging observations, applying exposure corrections, removing background) included in the catalog pipelines, they can be used directly by the end-user to simplify significantly the effort required to perform detailed scientific analyses of properties for extensive samples of sources.

Data access and documentation for CSC release 2.0 is available through the release 2 website (*http://cxc.cfa.harvard.edu/csc2/*). The documentation describes the content and organization of the catalog in detail and lists important caveats and limitations that should be reviewed prior to using the catalog data.

The primary end-user data query and access tool for CSC 2.0 is the downloadable CSCview application (*http://cda.cfa.harvard.edu/cscview/*), which allows arbitrary sets of tabulated properties to be retrieved based on combinations of positional searches and user-specified constraints on any set of properties. CSCview returns tabulated results that may be saved to a file or shared with another application through the SAMP messaging protocol, as well as providing options to retrieve any desired science-ready FITS data products.

New this year is a visual interface to CSC 2.0 (see Figure 1), developed using the WorldWide Telescope (WWT). The

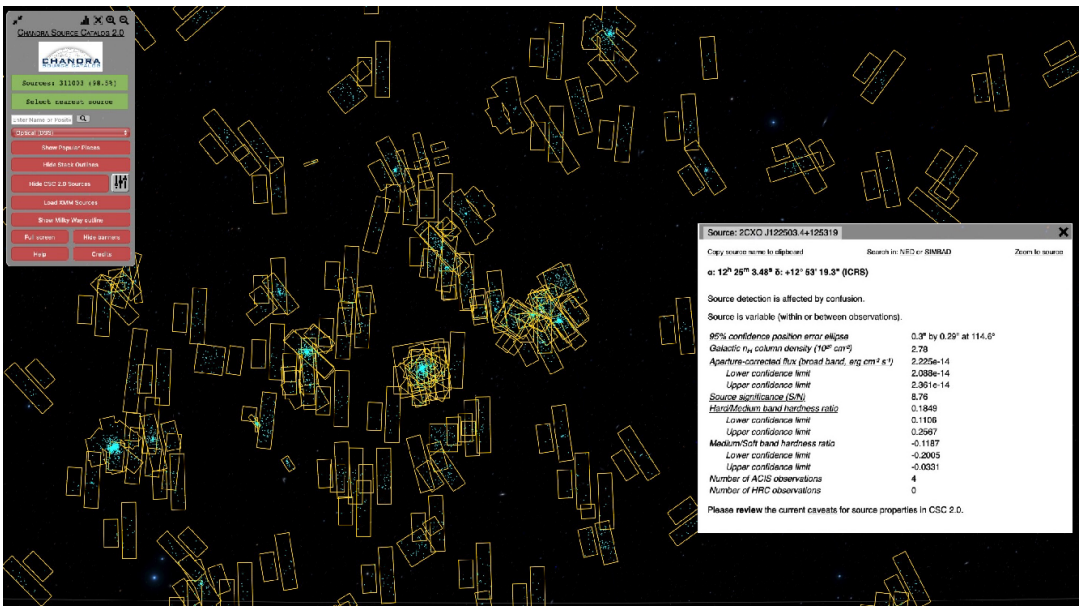

Figure 1. A new WWT-based interface provides graphical access to CSC 2.0. The interface displays the outlines of the stacked-observations included in the catalog, as well as the catalog sources. Basic information about each source is available directly on the screen. Recent enhancements allow source properties and stacked-observation event lists to be sent via SAMP to VO-enabled tools such as TOPCAT and DS9.

sky coverage and content of the catalog can be explored through this interface, which exposes the outlines of the stacked-observations as well as the locations of the catalog sources. Clicking on a source displays a box with a basic set of source properties.

> *Tip: When viewing the basic source properties in the WWT interface, click on "Copy source name to clipboard" to capture the source name. This name can then be pasted into a CSCview search on name to retrieve more properties or data products associated with the source.*

The WWT interface will continue to be enhanced over the coming months. Additionally, standard Virtual Observatory (IVOA) protocol interfaces to CSC 2.0, such as TAP, SCS, and SIAP, will be available shortly.

Table 1. CSC 2.0 Tabulated Source and Detection Properties

FITS Data Products

Master Source	Aperture photometry probability density functions (PDFs) Multi-band aperture photometry (photon and energy fluxes, spectral model energy fluxes), hardness ratios, spectral model fits for each Bayesian block
Detection Region	Stacked-observation and single-observation region definitions, event lists Multi-band stacked-observation and single-observation images, exposure maps, position error MCMC draws, aperture photometry PDFs Multi-band single-observation PSFs, light curves Single-observation PHA spectrum, RMF, ARF
Stacked-Observation Full Field	Event list, Field-of-View (FoV), merged detection list Multi-band images, background images, exposure maps, limiting sensitivity
Single-Observation Full Field	Event list, aspect solution and histogram, bad pixel map, FoV, pixel mask Multi-band images, background images, exposure maps

Table 2. CSC 2.0 Science-Ready

Master Source	Source name, position and position error ellipses, significance, source flags, multi-band deconvolved extent, multi-band aperture photometry (photon and energy fluxes, spectral model energy fluxes), hardness ratios, spectral model fits, multi-band intra- and inter-observation temporal variability
Stacked-Observation Detection	Position and position error ellipses, multi-band significance, detection flags and codes, multi-band deconvolved extent, multi-band aperture photometry (net counts and count rates, photon and energy fluxes), aperture parameters, hardness ratios, multi-band intra- and inter-observation temporal variability
Single-Observation Detection	Detector position, multi-band significance, detection flags and codes, multi-band raw, PSF, and deconvolved extent, multi-band aperture photometry (total counts, net counts and count rates, photon and energy fluxes, spectral model energy fluxes), masked aperture parameters, spectral model fits, multi-band intra-observation temporal variability