The Chandra Source Catalog 2.0: Combining Data For Processing

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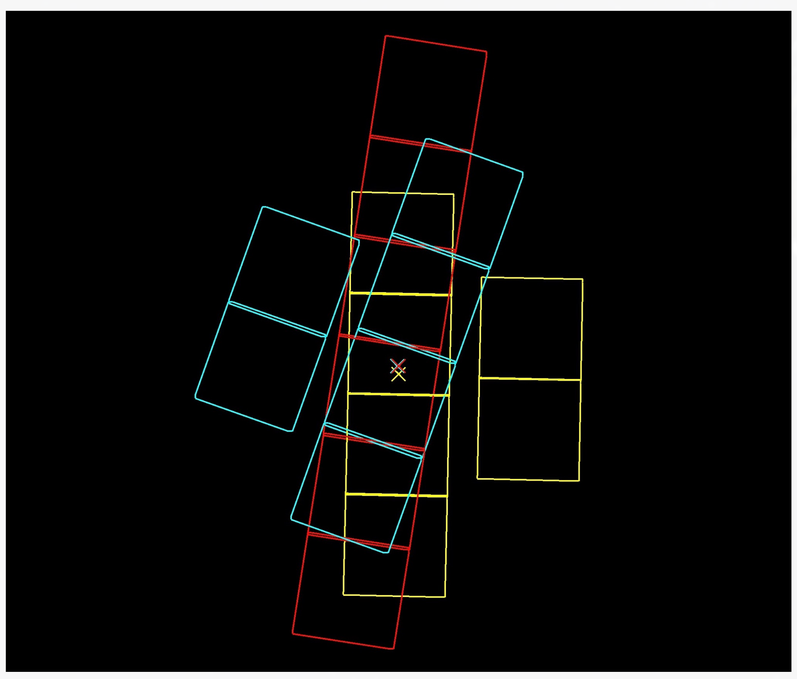
The Second Chandra Source Catalog (CSC2.0) combines data at multiple stages to improve detection efficiency, enhance source region identification, and match observations of the same celestial source taken with significantly different point spread functions on Chandra's detectors. The need to group data for different reasons at different times in processing produces a hierarchy of groups to which individual sources belong. Source data are initially identified as belonging to each Chandra observation ID and number (an "obsid"). Data from each obsid whose pointings are within sixty arcseconds of each other are reprojected to the same aspect reference coordinates and grouped into stacks. Detection is performed on all data in the same stack, and individual source detections are identified. Finer detection position and region data are determined by further processing source detections whose photons may be commingled together, grouping such detections into bundles. Individual stacks which overlap to any extent are grouped into ensembles, and all stacks in the same ensemble are later processed together to identify celestial sources and determine their properties.

Example Stack



FOVs of a 3 obsid stack: GRB 010222

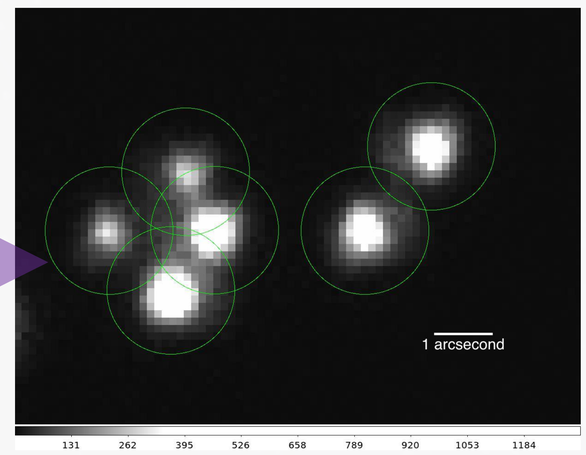
Stacks: Groups of Obsids

- A major improvement in CSC2.0 is the use of combined Chandra observations (obsids) for detecting X-ray sources.
- All obsids with pointings within one arcminute of each other are grouped together in a "stack".
- Chandra's widely varying Point Spread Functions (PSFs) are roughly the same size for obsids within the same stack due to the one arcminute limit.
- Source detection is performed on stacks to observe fainter sources than were observed in CSC1.0, consistent with similar PSF sizes.
- Due to different instrument characteristics, obsids from different instruments (ACIS and HRC) are not merged into the same stack.
- On the left is an example stack showing three obsids' Fields of View (FOVs) with the outlines of individual ACIS chips visible. Pointings, marked with X's, are within one arcminute. The FOVs of different obsids are shown in separate colors.

Bundles: Groups of Detections

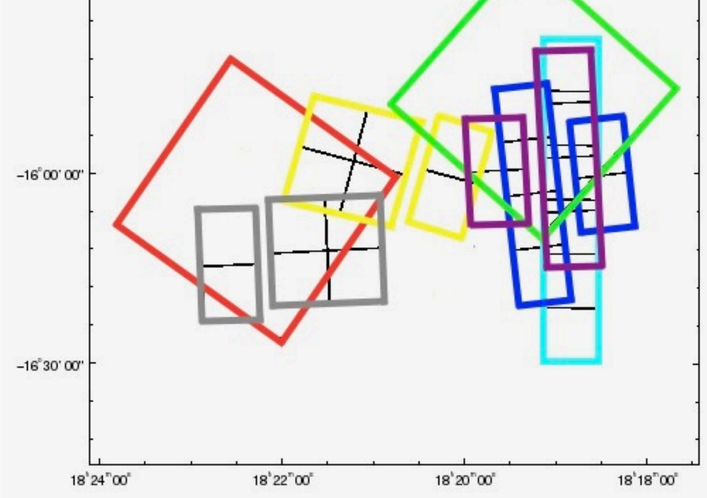
- The CSC Maximum Likelihood Estimator (MLE) source fitting routine refines detection position and calculates likelihood and errors.
- Detections near each other can result in commingled photons, and must be fit together in MLE.
- Groups of detections fit together in MLE (and aperture photometry) are called "bundles".
- On the right are two sets of example bundles with overlapping regions; a four detection bundle and a separate, two detection bundle.

Example Bundles



Photons and regions from 6 detections

Example Ensemble



FOVs of 7 Stacks (1 obsid in each)

Ensembles: Groups of Stacks

- To match all stack detections of the same celestial source together, all contiguously overlapping stacks are grouped together into an "ensemble".
- An ensemble is processed as a single unit to identify sources and their properties.
- There are 7287 stacks and 4404 ensembles in CSC2.0.
- Most ensembles consist of just a single stack, but an exponentially decreasing number of ensembles contain more and more stacks. The largest ensemble (around Sgr A*) has 379 stacks.
- On the left is an example ensemble of 7 stacks, each of which happens to consist of a single obsid. The FOVs of different stacks are shown in separate colors.

CHANDRA SOURCE CATALOG

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