HiPS: the Future of *Chandra* Data Visualization

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The growing size and complexity of astronomical observations represent an opportunity for discovery and, simultaneously, a challenge for the access and visualization of the data. With *Chandra* observations covering 790 square degrees (~2% of the sky) scattered throughout the sky with multiple overlapping observations, the task of providing a general and flexible framework for the visualization and exploration of this large, heterogeneous dataset can be arduous. The challenge is compounded by the need to keep up with the dramatic improvement of internet technologies and platforms for web-based visualization that are constantly striving to provide users with a seamless and effective experience.

The *Chandra* X-ray Center (CXC) has decided to implement a novel type of data designed to allow easy access, visualization and navigation of public *Chandra* images across all angular scales observed, from large regions of the sky to single pixels. This data product, called Hierarchical Progressive Survey (HiPS), combines single images into a multi-resolution hierarchical structure that can be interactively explored by zooming and panning. HiPS, developed by the Centre de Données astronomiques de Strasbourg (CDS) and currently being codified as a standard by the International Virtual Observatory Alliance (IVOA), was originally designed to visualize all-sky imaging datasets but is also appropriate for the sparse sky coverage achieved by *Chandra*.

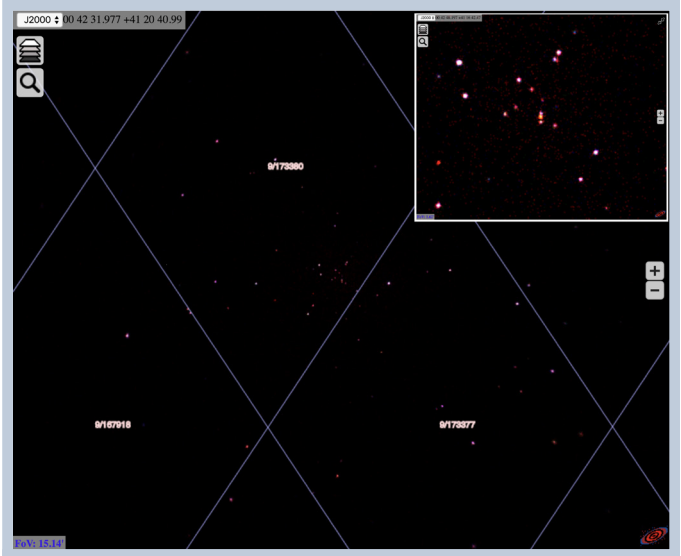

Figure 1: example Chandra HiPS color prototype of the central region of M31. The lines represent the HEALPix grid, the numbers the indices of the tiles and, in the lower left corner, the FOV of the image is shown (~15'). In the upper right corner, a close-up of the core of M31 (FoV: 1.62') is shown.

HiPS implementation employs the HEALPix tessellation scheme to produce a hierarchy of images resampled onto distinct HEALPix maps of increasing angular resolution and efficiently indexed for quick retrieval. Single, overlapping observations are combined and contribute to each pixel in the common areas for all maps. HiPS are "progressive" because higher order tiles (covering smaller regions of the sky at higher resolutions) are progressively retrieved as one zooms in. To keep the amount of data downloaded small without noticeable degradation of the image quality at each scale, only maps of suitable orders are retrieved while browsing and pixels at each order are grouped into "tiles", the basic data units transmitted to the client from the HiPS server.

HiPS can be displayed in both desktop applications (Aladin; http://aladin.u-strasbg.fr/) and web-based interfaces, like ESAsky (http://sky.esa.int/) and JUDO2 (https://darts.isas.jaxa.jp/astro/judo2/). The HiPS specification allows linking to the metadata of single observations and overlays of different types of data, like catalogs of sources and footprints, providing support for a comprehensive presentation of all data available.

The CXC is working to prototype *Chandra*-based HiPS. The final official color and grayscale *Chandra* HiPS will contain all public archival observations to date, and new, incremental HiPS will be created regularly as new data become public. This technology will help to maximize the scientific return of the mission by facilitating the access to *Chandra* data through as many channels as possible. HiPS also represents a cornerstone for the future of the archival interfaces that will be offered by the *Chandra* Data Archive (http://cxc.cfa.harvard.edu/cda/), as it will provide the infrastructure to implement new features designed to enhance the productivity of astronomers by making the X-ray Universe seen by *Chandra* more easily discoverable and navigable. ▪

References and Resources

HiPS → Ferrique, P. et al . 2015, A&A, 578A, 114F
HEALPix → http://healpix.sourceforge.net/