Perseus in Sicily: From Black Hole to Cluster Outskirts
Proceedings IAU Symposium No. 342, 2018
K. Asada, E. de Gouveia Dal Pino, M. Giroletti,
H. Nagai & R. Nemmen, eds.

doi:10.1017/S174392131800594X

Chandra Early-Type Galaxy Atlas

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Abstract. The hot ISM in early-type galaxies (ETGs) plays a crucial role in understanding their formation and evolution. The structural features of the hot gas identified by Chandra observations point to key evolutionary mechanisms, (e.g., Kim & Pellegrini 2012). In our Chandra Galaxy Atlas (CGA) project, taking full advantage of the Chandra capabilities, we systematically analyzed the archival Chandra data of 72 ETGs and produced uniform data products of the hot gas properties. The main data products include spatially resolved 2D spectral maps of the hot gas from individual galaxies. We emphasize that new features can be identified in the spectral maps which are not easily visible in the surface brightness maps. The high-level images can be viewed at the dedicated CGA website, and the CGA data products can be downloaded to compare with other wavelength data and to perform user-specific analyses. Utilizing our data products, we will further address focused science topics.

Keywords. galaxies: elliptical and lenticular, cD – X-rays: galaxies

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72 E and S0 galaxies (type < 0, based on RC3) from the Chandra archive through AO15 (earlier work by Diehl & Statler 2007 used data only up to AO4) were selected and homogeneous data products of the spatially resolved 2D distribution of spectral properties of the hot gas were explored.

These 2D *spectral* maps (of the hot gas temperature, emission measure, projected pseudo-pressure and projected pseudo-entropy) can reveal unique features, which may not be visible in 1D radial profiles or the 2D surface brightness maps alone. We make use of newer and improved data analysis (and statistical) techniques (e.g., CIAO tools and scripts), instrument calibration data (in Chandra CALDB), and atomic data (in ATOMDB).

We have developed our own analysis pipelines to apply robust data reduction methods in three main steps: (1) merging multiple observations and imaging diffuse emission after point sources are excluded, (2) adaptively binning to determine optimal spectral extraction regions, (3) extracting spectra from each spatial bin, fitting and mapping spectral parameters.

We provide the Chandra Galaxy Atlas data products in a dedicated CGA website. The 2D images can be directly viewed on the browser and the necessary data products can be downloaded for further analysis. For those who want to take a quick look at the hot gas distribution and the thermal structure,the figures posted on the CGA website can be useful. A screenshot example is in Figure 1. The left panel shows a part of the CGA image gallery with postage stamp images of diffuse gas of individual galaxies and the right panel show the spectral maps of NGC 4649 (4^{th}-row 2^{nd}-column in the left panel) which is displayed simply by clicking the galaxy image on the left panel.

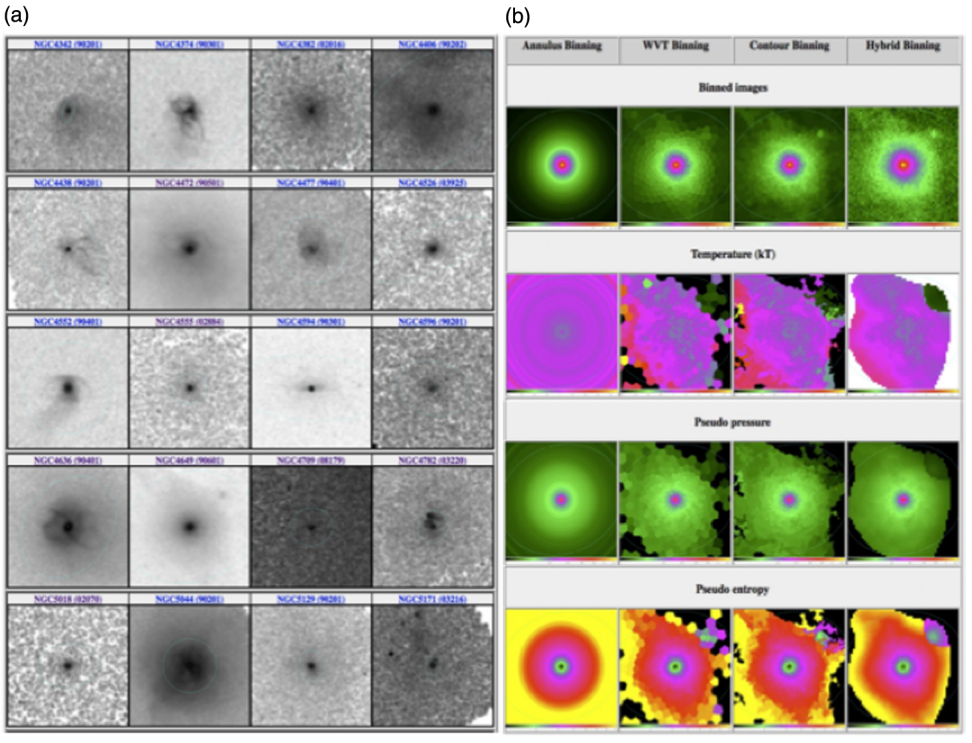

Figure 1. (a) The image gallery of diffuse gas from individual galaxies available in the CGA web site. (b) An example of a set of spectral maps (binned image, temperature map, pressure map and entropy map from top to bottom) of NGC 4649. (The color image is available in the online version.)

Data products are made available in two packages. The main package consists of the high-level data products, e.g., point source removed and filled, exposure corrected images (jpg/png and FITS format) in multiple energy bands to best illustrate the diffuse hot gas distribution, derived temperature maps (jpg/png and FITS format) in various adaptive binning methods to show the hot gas thermal structure. They can be used to get an overview, to obtain the necessary hot gas quantities and to compare them with data at other wavelengths with no additional X-ray data reduction. For more specific analyses, e.g., to extract and fit X-ray spectra from user-specified regions, we provide all the necessary data in the supplementary package, e.g., event files per obsid and per ccd.

Utilizing our CGA data products, we are investigating a range of focused scientific questions, including the hot gas morphology, global properties, radial profiles, X-ray based mass profiles (see Paggi *et al.* 2017 as an example of our CGA data usage), and LMXBs (see Kim *et al.* 2018 in prep).

References

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https://doi.org/10.1017/S174392131800594X Published online by Cambridge University Press