TARTARUS – AN ASCA AGN DATABASE

T.J.Turner[1,2], K.Nandra[2,3], D.Turcan[2,4], I.M.George[2,3]

1) University of Maryland Baltimore County, 1000 Hilltop Circle, Baltimore, MD 21250; 2) Laboratory for High Energy Astrophysics, Code 660, NASA/Goddard Space Flight Center, Greenbelt, MD 20771; 3) Universities Space Research Association; 4) University of Maryland College Park

ABSTRACT

Tartarus is a database of products from *ASCA* observations of AGN. We discuss access to and products available within the database, and outline the data-reduction process.

KEYWORDS: astronomical data bases; X-ray:galaxies; galaxies:active

1. INTRODUCTION

Version 1 of the Tartarus database was released 1999 July 27, and may be accessed via http://tartarus.gsfc.nasa.gov. The database contains reduced images, spectra and light curves for *ASCA* observations of AGN and is currently complete up to the end of the AO-5 phase of the mission. We have provided significant improvements over standard mission products by including background spectra and light curves, optimizing the data-reduction for faint sources, performing a number of checks and including some supplementary information. In the initial release 444 reduced sequences were made available out of 473 in the archive. A few failed runs have been excluded until the problems can be isolated. We expect Version 2 of Tartarus to include these previously failed sequences and to have other minor existing problems fixed. We will continue to reduce AGN sequences as they enter the public domain, until all "70000000 series" sequences are available. For up-to-date information please see the Tartarus web pages.

2. SUMMARY OF AVAILABLE PRODUCTS AND INFORMATION

The Tartarus home page allows access to the database via objected-sorted and sequence-sorted lists, and a search facility is available. For each sequence there is a web page summarizing important information about the observation (e.g. exposure time, observation mode, date), as well as basic information about the source such as count rates, fluxes and a basic spectral fit. Data products (gzipped tar files) can be downloaded from web pages or via anonymous ftp to tartarus.gsfc.nasa.gov (cd to pub/tartarus/). Thumb gifs indicate whether problems occurred during processing.

Three thumbs up is obviously a good sign, if one or more thumbs is down please see the processing log for details of the problem. Comments and questions can be sent to tartarus@athena.gsfc.nasa.gov.

Data products include:

- **IMAGES** Exposure-corrected, smoothed images are available in sky co-ordinates from the summed instrument pairs. The web page shows the summed sky image from GIS2 and GIS3. The expected position of the target source is shown, based on the RA/DEC given by the observer. Other AGN lying within the field are noted.
- **DETECTOR IMAGES** Images are shown on the web page in detector coordinates with extraction regions overlaid.
- **LIGHT CURVES** Source and background light curves are available for each instrument, in 32 s bins. Selected light curves are available in 128 or 5760s bins.
- **SPECTRA** Integrated source and background spectra are available for all four detectors. The web page shows a fit to a powerlaw model along with the data and the residuals to the fit. Users can retrieve the spectral files alone in a gzipped tar file, the XSPEC command file `sequence_webfit.xcm` allows users to start their analysis at the fit shown on the web page.

3. DATA REDUCTION SUMMARY

The data reduction process is outlined here. The version of FTOOLS and Tartarus scripts used will change with time, so please see the web pages and log files for version numbers.

3.1. Examining the Observation Parameters

Observation catalogs are constructed for all four instruments (SIS0,1 and GIS2,3) using XSELECT. Filter files are merged into one and sorted by time (using FMERGE, FSORT). The datamode used is `FAINT` when all files are in `FAINT` mode, otherwise `BRIGHT` mode data are used. The `BR_EARTH` angle is determined as the angle from the earth where the SIS0 event rate in the nominal chip becomes lower than 200 c/s (then 5 degrees is added to be conservative, but never going lower than the constraints noted in the next section).

3.2. Extracting Events

The extraction command files are set up to include only data taken outside of the SAA, having angular offset from nominal pointing < 0.01 degrees, $RBM_{CONT} <$ 500 (radiation belt monitor) and $COR > 6$ (cut-off rigidity, GeV/c). For the SIS we require $ELV > 10^{o}$ (angle from earths limb), `BR_EARTH` $> 20^{o}$ (angle from bright Earth), time after day/night terminator $> 50, 100, 200$ for 1,2,4 CCD modes, respectively, SIS pixel threshold $< 100, 75, 50$ cts for 1,2,4 CCD modes. For the GIS we require $ELV > 5^o$. A check is performed to determine whether good time exists for the observation. Events are extracted for all four instruments (SIS0,1 and GIS2,3) using XSELECT and the extraction command files.

3.3. Defining Regions

We create (XSELECT) and smooth (FGAUSS) sky and detector images for all detectors. The centroid is found by determining the pixel with the highest count in the smoothed image within radii $\sim 5'$ and $\sim 7'$ of the expected target position in the SIS and GIS, respectively (to minimize the risk of extracting a serendipitous source). Source extraction regions are centered on these centroid positions. Source regions are circles of radii 45 (SIS) or 27 (GIS) pixels (using XSELECT detector image defaults which have the SIS data spatially-binned by a factor 4), corresponding to $4.86'$ and $6.75'$, respectively. The background region for the SIS is everything outside of a circle of radius 47 pixels but inside the nominal chip (S0C1 or S1C3) . For the GIS the background region is an annulus with inner radius 35 and outer radius of 55 pixels centered on the source. A check is made that SIS0, SIS1 centroids and GIS2, GIS3 centroids agree within 1 arcmin. A combined and smoothed sky image is created for the SIS0,1 pair and the GIS2,3 pair and then a check is made that the resulting SIS and GIS centroids agree within 1 arcmin.

3.4. Extracting Additional Products

SISPI is run on the SIS0 and SIS1 event files. Source and background spectra are extracted from the defined regions using XSELECT. Source and background mini-event files are extracted for SIS0 and SIS1 in the full (0.5–10 keV), hard (2–10 keV) and soft (0.5–2 keV) energy ranges from the defined regions using XSELECT. Source and background event files are extracted for GIS2 and GIS3 in the full and hard energy range.

3.4.1. Spatial Analysis

Four-channel spectra are temporarily created for use in making temporary efficiency maps (to speed up the run-time compared to using full resolution spectra for the energy-weighting). Exposure maps and sky images are created from the efficiency maps using the attitude information for the observation with ASCAEXPO. The maximum attitude deviation allowed is $15''$, and the image rebinning factor is 8. Combined, smoothed, exposure-corrected sky images are created for the SIS0,1 and GIS2,3 pairs using XIMAGE. The GIS image on the web page has overlaid a green circular marker showing the expected position of the target based on the RA and DEC *given by the observer* (taken from the attitude file header).

3.4.2. Spectral Analysis

If SIS datamode is `BRIGHT` then SIS spectra will have 512 pha channels. If the `GISBITFIX` problem is present then GIS3 spectra will have 128 channels. All other spectra have 1024 channels. Bad channels are then set such that for the SIS only data between 0.6 – 10 keV are denoted "good" and used in the spectral fitting. For GIS observations prior to June 1996 data between 0.7 – 10 keV are good, observations after that date use only data between 1.0 – 10.0 keV. The data are grouped to have at least 20 counts per spectral bin. Ancilliary response files (ARFs) are made using the spectral file, and assuming a point-source at the center of the region file. Redistribution matrix files (RMFs) are made using SISRMG.

A power law is fit to the data of all four instruments using XSPEC. Individual instrument normalizations were allowed to vary relative to SIS0 to allow for small uncertainties in the instrument cross-calibrations. The fit has three free parameters; photon index, normalization of the powerlaw and absorbing column and is performed on the 0.6-5 keV data (excluding data below 1 keV for the GIS) plus 7.5-10 keV data, i.e. excluding the iron Kα regime. The Galactic line-of-sight column is noted for comparison. The 5.0-7.5 keV data are read in after the fit has minimized, these data are included in the plots and contribute towards the fit statistic shown. The $\chi^2 + 4.61$ error ranges are calculated for N_H and Γ. The flux under the model is calculated in the 0.5–2 keV and 2–10 keV bands (from SIS0). For accuracy, the fluxes were obtained from a double powerlaw fit, not shown on the web pages (which will soon be available in BROWSE).

3.4.3. Timing Analysis

Combined SIS0,1 and GIS2,3 light curves are created using LCURVE. The instrument-pair light curves are the sum of the two individual instruments. Time series are created from the source region and background region for each instrument. Three energy ranges are used (full, hard, soft) and three binning intervals (32, 128, 5760 seconds). Combined SIS0,1 and GIS2,3 count rates are calculated from combined SIS and GIS light curves for the full, soft and soft energy ranges with background subtracted (The scaling parameter (BACKSCAL) is determined from source and background spectral files using FKEYPRINT).

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