D I A N A

The Distribuited Italian Astronomical Network Archive

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ABSTRACT

DIANA is a joint effort of three italian astronomical observatories and the Italian Space Agency's Science Data Center. DIANA is a step towards the creation of a modern high energy astrophysics archive and advanced database system with extensive access to multiwavelength information. The project is distributed across different Italian research sites (O.A. Brera, O.A. Palermo, O.A. Roma and SDC-ASI), reflecting on-going programs and expertise and is designed to provide an efficient online service to the community. We have currently achieved most of the original main goals, such as: on-line access to distributed astronomical databases through a common interface; systematic application of advanced detection algorithms based on the home developed wavelet transform to the ROSAT HRI and PSPC data. We are also working on the developement of analysis pipelines (including wavelet transform detection) for the CCD data, in view of the application to advanced X-ray instruments (such as Chandra, XMM, Swift, etc.), in which our groups are involved, and on further improving the interactive access to astronomical data.

DIANA: RATIONALE

DIANA (Distributed Italian Astronomical Network Archive) is a project, supported by italian Consorzio Nazionale per l'Astronomia e l'Astrofisica (CNAA) and Agenzia Spaziale Italiana (ASI), aimed at giving access to multiwavelenght astronomical data with a special attention to high energy astronomical missions (Einstein, BeppoSAX, ROSAT, ASCA, etc).

The project is distributed across different italian sites reflecting on-going programs and expertise of the involved scientists and it is designed to provide an efficient online service to the community.

The institutions presently involved are:

- Palermo *"G. S. Vaiana"* Astronomical Observatory (OAPa);
- Brera/Merate Astronomical Observatory (OAB);
- Roma Astronomical Observatory (OAR)
- ASI Science Data Centre (ASI-SDC)

These institutions joined their expertise with the aim of building an integrated polycentric system with a unified Web access to data stored at DIANA sites where interfaces and pipeline development as well as data processing have been performed as parallel efforts. These efforts have also the important role of maintaining the visibility and high rank expertise of involved scientists at the international level.

The core of DIANA is a large body of data coming from the italian national X-ray space mission BeppoSAX and innovative reprocessing of public archive data of X-ray satellites (ASCA, ROSAT) with data processing results making available for public use on the Web.

DIANA: GOALS

DIANA makes available to the astronomical community a large set of multiwavelenght data with emphasis on X-ray ones. A common interface, currently under development at ASI-SDC, allows the access to databases at various DIANA sites. To satisfy those desiderata we had to achieve some goals, such as:

- Systematic pipeline application of innovative detection algorithms based on Wavelet Transforms to the ROSAT PSPC and HRI data;
- On-line access to spatial and timing analysis tools;
- Automatic search in catalogs (radio, optical, infared);
- On-line overlay of maps taken at other wavelengths on X-ray images and autometed retrieval and display of finding charts;
- Development of advanced algorithms for the statistical classification of X-ray sources.

Each institution addressed these points developing solutions for database management and for Web interfaces to databases.

In the following we will present current DIANA capabilities through few selected examples of its usage through the Web.

OAPa/CfA ROSAT PSPC CATALOGUE

The OAPa contributes to DIANA with a ROSAT PSPC pipeline that has allowed a sistematic automated reanalysis of ROSAT PSPC public archive observations, performed at Osservatorio Astronomico di Palermo and at Harvard-Smithsomian Center for Astrophysics (CfA) (G. Mackie et al. 1995) The pipeline is based on IRAF packages with implementation of new modules for processing of data. In particular two algorithms were developed, to improve ROSAT standard software data processing: the first to screen out enhancements of background count-rate due to the particle or solar scattered radiation contaminations (Bocchino et al. 1998), and the second to find sources with a Wavelet Transform method able to efficiently detect weak point like source as well as extended ones with a point spread function that varies across the field of view (Damiani et al. 1997a, Damiani et al. 1997b). After detection step, source identification is performed matching various optical, radio, infrared and X-ray catalogues. Studies in selected regions show a significative increase of detected sources with respect “standard” methods , (e.g. Sciortino et al. 1998). As today we have processed almost the entire ROSAT PSPC public archive, detecting more than 100,000 sources, saving data results on a relational database and on a CD-ROM jukebox.

The OAPa/CfA ROSAT PSPC database is stored on a LINUX based server running a SYBASE DataBase Management System (DBMS). Web interfaces to the database has been written as HTML and PHP scripts, the latter is a wide diffuse language for Web applications which offers simple tools for a large sets of free (MySQL, Postgres) and commercial (ORACLE, SYBASE, INFORMIX) DBMS.

The start point to operate on Diana at OAPa is:

`http://dbms.astropa.unipa.it`

In FIGURE 1 we present the Web source–search tool, while in FIGURE 2 an example of a source–search results. Other search tools have also been implemented.

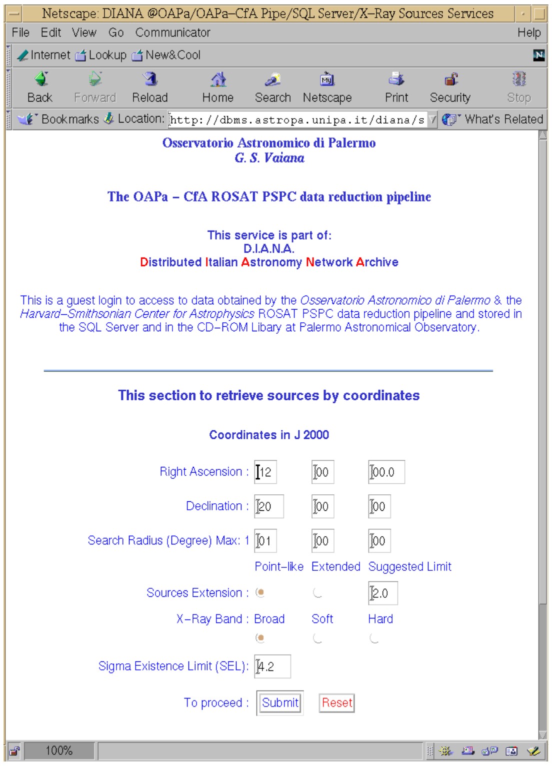


Figure 1. The DIANA Web search tool at OAPa.

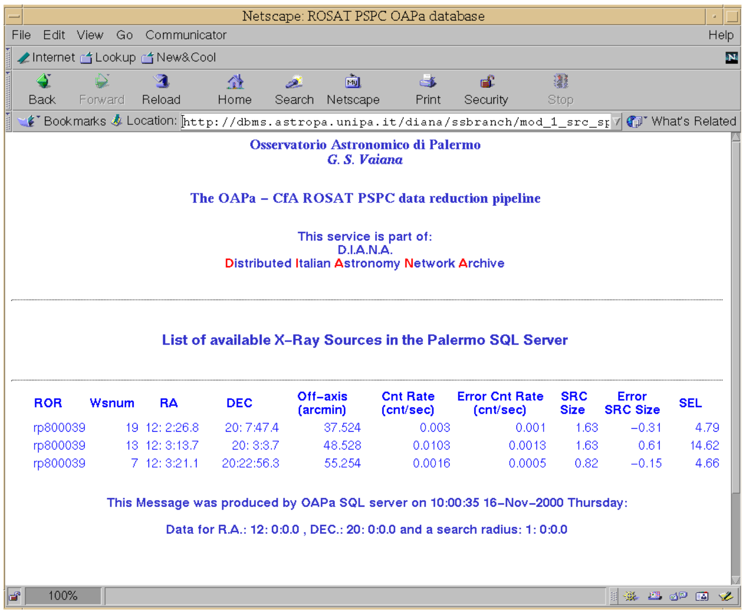


Figure 2. An example of searching results output.

BRERA MULTISCALE WAVELET CATALOGUE

The effort of the Brera Astronomical Observatory concentrates in the study of new detection and characterization algorithm for X–ray images. In particular, the Brera team has developed a detection algorithm based on the Wavelet Transform (WT) and have systematically analysed all ROSAT-HRI public data (more than 3100 observations). The WT is specifically suitable to detect and characterize extended sources and to properly detect point sources in very crowded fields. Moreover, the HRI images are characterised by good angular resolution, allowing for accurate determination of the source extension and position.

We obtained the BMW (Brera Multiscale Wavelet, see also the dedicated accompanying paper by Panzera et al., 2001) catalogs with more than 19 thousands sources for the bright–catalog ($\sim 4.2\sigma$). For each detection we have information on the X-ray flux and extension, allowing for instance to select complete samples of extended X-ray sources such as clusters of galaxies (see Moretti et al. this conference) or SNR. The catalog is part of the DIANA database, and is public. BMW can be searched through the DIANA web interface at OAB:

`http://vela.merate.mi.astro.it/~xanadu/browser/sbmw.html`.

In FIGURE 3 we present the browser interface, while in FIGURE 4 the result of the search in the field of M47.

For furher details see: Lazzati et al. (1999), and Campana et al. (1999).

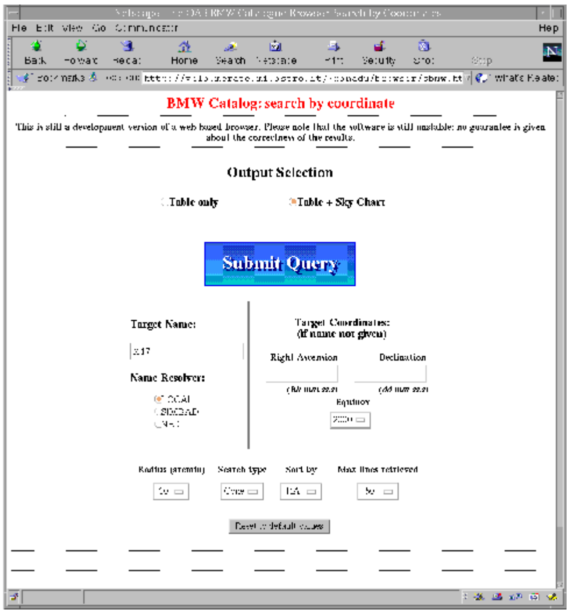


Figure 3. The browser interface to access the BMW catalog at the Brera astronomical observatory.

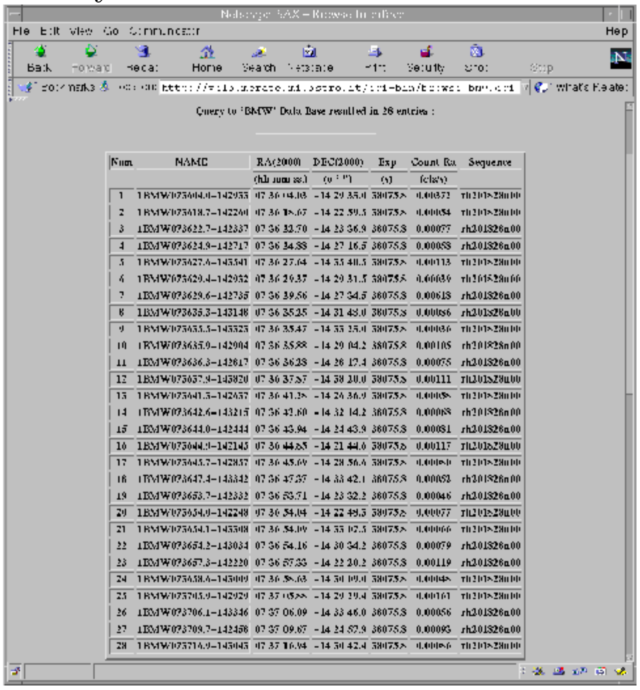


Figure 4. The catalog of BMW sources detected within 10' from the nominal centre of M47. For each source the position (R.A. and Dec.), the exposure time and the count–rate are given. The ROR number of the observation is also indicated.

DISTRIBUTED ASTRONOMICAL MULTIWAVELENGTH ARCHIVE

Roma Astronomical Observatory (OAR) contributes to DIANA with a system, accessible through a WEB interface, to compare images, catalogs and data in different bands: DAMA.

The DAMA can perform various tasks:

- Automatical retrival of images and source catalogs from archives of astrophysical data based in Italy, Europe and the US.
- Access to ROSAT PSPC/HRI and Einstein IPC/HRI event files, and the BeppoSAX and ASCA data, stored at ASI-SDC and OAR on magnetic disks and on CD-ROM jukeboxes.
- Automatic images overlay. It is, at the moment, working for optical, radio and X-ray maps to help the search for counterparts in the different bands. Radio contours are automatically superimposed over POSS images. It is also possible to obtain an overlay with sources positions from other catalogues.
- Creation of ”color” images using source catalogs at different wavelenghts. At the moment this tool works for optical catalogs.

Future plans include:

- The integration in the system of the NIR data of the 2MASS and DENIS surveys as soon as they will be available on line.
- Plot of the Radio to X-ray Spectral Energy Distribution of sources with entries in different catalogs.
- Import of user provided maps to be used by the system for overlays.
- The possibility for the user to save all the files produced during the remote session (e.g. FITS, GIF, PS, tables etc.) on his own computer.

The OAR has also supported ASI-SDC Interactive Archive in the development of tools to the timing analysis of astronomical dataset.

DAMA can be accesses at:

`http://argos.mporzio.astro.it/ia`

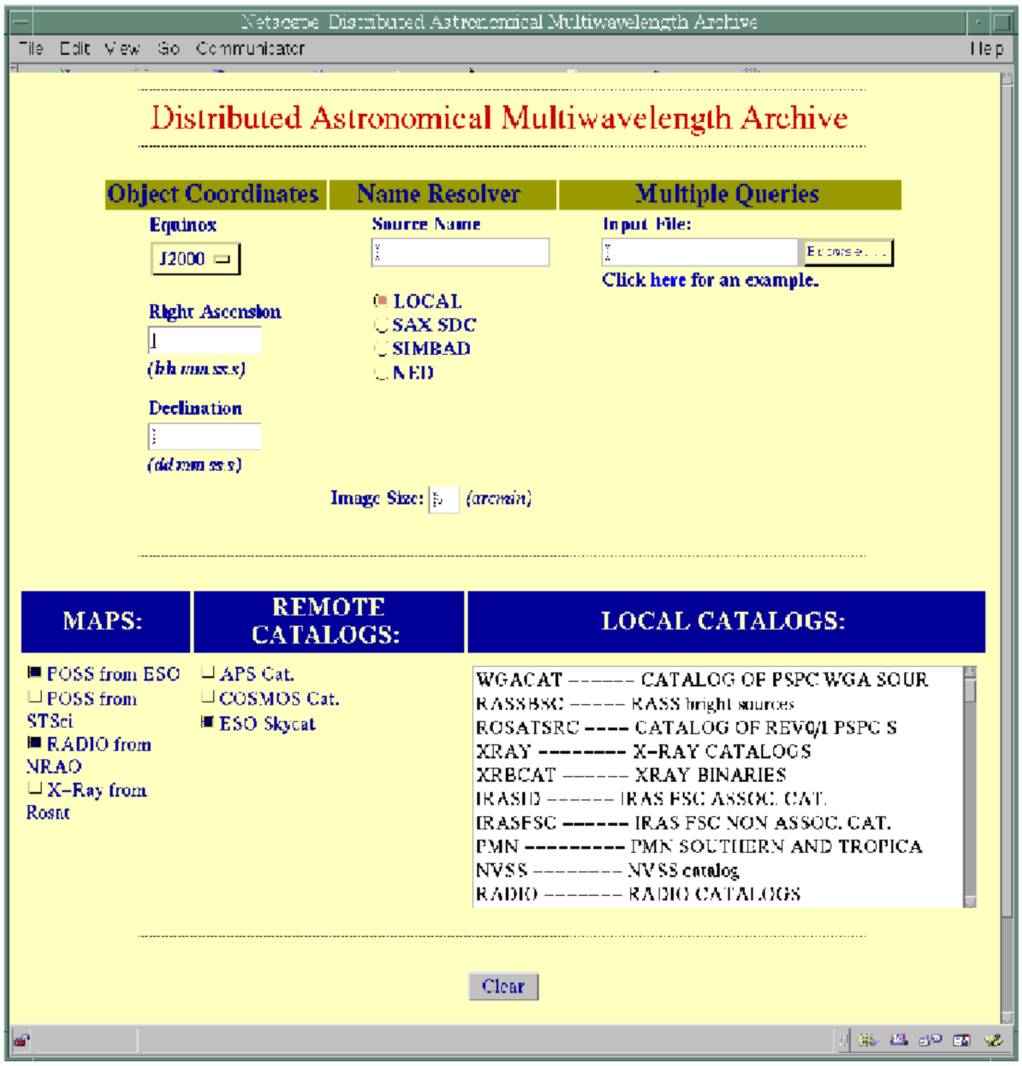


Figure 5. The interface to access the DAMA service at the Roma astronomical observatory.

MULTI-MISSION INTERACTIVE ARCHIVE AND CATALOGUE BROWSER

The ASI Science Data Center concentrates its efforts on developing a common Web interface to the other sites involved in DIANA project, as well as to the BeppoSAX data and other optical and radio archives.

From the Web start point users have access to BeppoSAX, ASCA, ROSAT, and Einstein archives hosted at SDC or to ROSAT results from HRI and PSPC data processing pipelines respectively at Brera and Palermo observatories.

ASI-SDC is developing a set of flexible tools to interrelate databases. These allows the users a) to extract information by *on-the-fly* cross-correlation of available astronomical data, b) to produce finding charts with overlay from a large number of astronomical catalogues, and c) to interactively process X-ray data by using user local WEB browser.

Particular attention is being devoted to the development of client-side tools (written in JavaScript) that, allow the user to explore in a fast, and interactive way the result of database searches.

The ASI-SDC Interactive Archive URL is:

`http://brunello.sdc.asi.it/diana/`

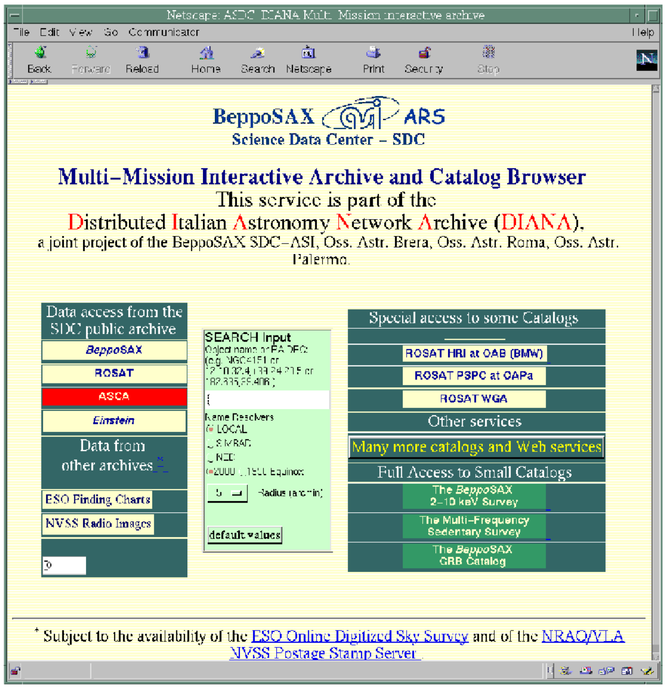
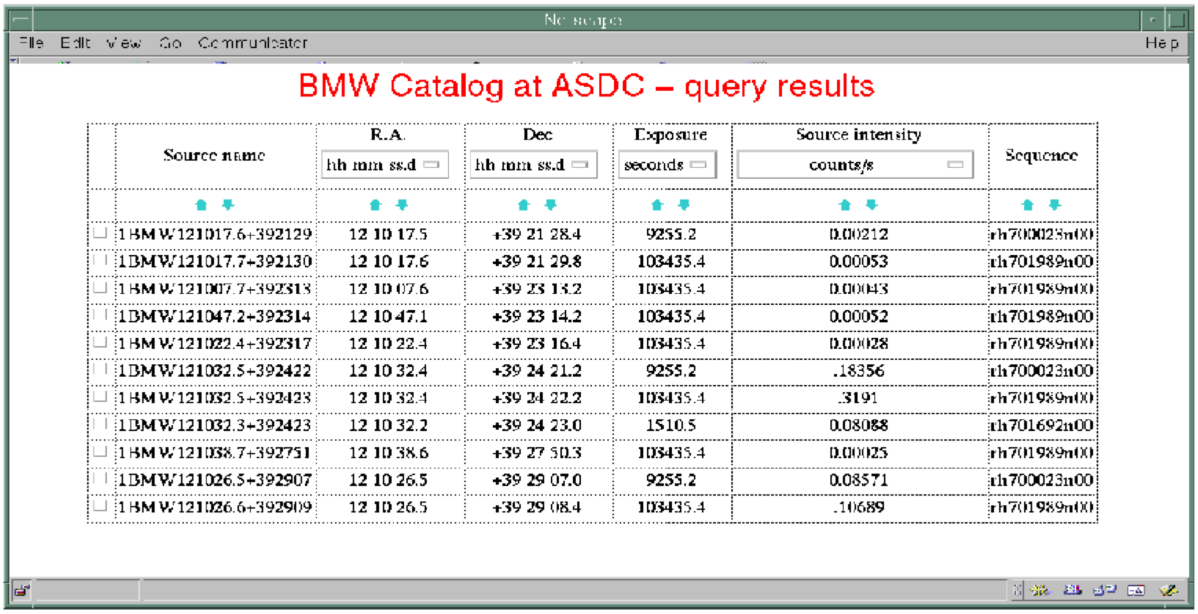


Figure 6. The Web page to access the ASI-SDC services.



BMW Catalog at ASDC – query results

Source name	R.A. (hh mm ss.d)	Dec (hh mm ss.d)	Exposure (seconds)	Source intensity (counts/s)	Sequence
1BMW121017.6+392129	12 10 17.5	+39 21 28.4	9255.2	0.00212	rh700023n00
1BMW121017.7+392130	12 10 17.6	+39 21 29.8	103435.4	0.00053	rh701989n00
1BMW121007.7+392313	12 10 07.6	+39 23 13.2	103435.4	0.00043	rh701989n00
1BMW121047.2+392314	12 10 47.1	+39 23 14.2	103435.4	0.00052	rh701989n00
1BMW121022.4+392317	12 10 22.4	+39 23 16.4	103435.4	0.00028	rh701989n00
1BMW121032.5+392422	12 10 32.4	+39 24 21.2	9255.2	.18356	rh700023n00
1BMW121032.5+392423	12 10 32.4	+39 24 22.2	103435.4	.3191	rh701989n00
1BMW121032.3+392423	12 10 32.2	+39 24 23.0	1510.5	0.08088	rh701692n00
1BMW121038.7+392751	12 10 38.6	+39 27 50.3	103435.4	0.00025	rh701989n00
1BMW121026.5+392907	12 10 26.5	+39 29 07.0	9255.2	0.08571	rh700023n00
1BMW121026.6+392909	12 10 26.5	+39 29 08.4	103435.4	.10689	rh701989n00

Figure 7. An example of interactive output from the ASI-SDC archive. Blue arrows allow row sorting according to column data, while a selection of different units (e.g. cts/sec, erg sec^{-1} cm^{-2}, μJy) is available for each column.

DIANA: SOME SCIENCE RESULTS

DIANA has been used and is used to address some scientific questions requiring the systematic access and analysis of large data sets. Among the various projects, some of which are still on-going, it is worth to mention:

- Studies of statistically complete sample of cluster of galaxies (Moretti et al. 2001).
- Study of X-ray selected sample of SNRs (Bocchino et al. 2001)
- Study of pre-main sequence stars in Star Forming Regions (Morale et al. 2000)
- Systematic search for coherent periodic signals in the BMW light curves (Israel et al. 1999)
- High Energy Large Area Survey with BeppoSAX (HELLAS), (Fiore et al. 1999)
- Studies of cosmological properties of large sample of BL Lacs, (Giommi, P. et al. 1999a and Giommi, P. et al. 1999b)

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