Current status of the CATS database

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Abstract. We describe the current status of CATS, a publicly accessible database (web-server \url{http://cats.sao.ru}) allowing one to search in hundreds of catalogs of astronomical objects discovered all along the electromagnetic spectrum. Our emphasis is mainly laid on catalogs of radio continuum sources observed from 30 to 15000 MHz, secondly on catalogs of objects such as radio and active stars, planetary nebulae, HII regions, supernova remnants (SNR), pulsars, nearby galaxies, AGN and quasars. CATS also includes the catalogs from the largest extragalactic surveys, like NVSS, FIRST, WENSS, VLSS, TXS, GB6, SUMSS, IRAS, 2MASS, SDSS, ROSAT, PGC, MCG, etc. In 2004 CATS comprised a total of \( \sim 10^9 \) records from over 400 catalogs in the radio, IR, optical and X-ray windows, including most of RATAN–600 catalogs. CATS is being expanded and updated, both with newly published catalogs as well as older ones which we have created in electronic form for the first time. We describe the principles of organization of the database of astrophysical catalogs and the main functions of CATS.

Key words: astronomical data bases: catalogs — radio astronomy: radio sources

Introduction

Vast amounts of astrophysical information are now being published, based on observations of small and large sky regions. Typically, this information includes coordinates of the observed objects and their physical characteristics in different wavelength ranges in the form of source catalogs. In fact, every new large-scale observational experiment produces a new catalog of objects. Modern astrophysics operates with source parameters obtained in different spectral wavelength ranges with the goal of obtaining the most detailed understanding of physical properties and the processes of radiation of these objects. The ability of using different catalogs makes this problem considerably simpler.

Over the past decades several different attempts have been made to combine large numbers of astronomical catalogs and make them accessible in a unified way, which can be classified grossly into two categories: databases of objects and catalog browsers. Examples of the former are NED (Helou et al. 1990; Mazzarella et al. 2002), Simbad (Egret 1983; Wenger et al. 2000) and LEDA (Paturel et al. 1997). Examples of the latter are Vizier (Ochsenbein et al. 2000) and AstroBrowser \url{http://heasarc.gsfc.nasa.gov/ab/}.

Motivated by RATAN-600 observation requirements, problems of radio source study, and the underrepresentation of radio source catalogs in the then existing object databases, the present authors decided, in 1995, to create CATS, the \textit{Astrophysical CATalogues Support System}. Following the radio astronomical needs, the architecture of operating system and the considerations expressed in the reviews by Andernach (1990, 1994, 1999), we chose to design CATS as a catalog browser rather than an object database, given that it would allow us to achieve a much better completeness in number of records, implying e.g. a more complete coverage of radio source measurements over the entire radio frequency window. We thus deliberately delayed the known problem of cross-identification of all the catalogues, as provided in NED, SIMBAD, or LEDA, to a later stage. In that sense CATS is ideally suited for the experienced researcher who is looking for the largest amount of data available, but willing and able to work out the correct cross-identifications by himself. His effort will be compensated for by a better completeness of the data than that obtained from other existing object databases.

The first steps of the creation of CATS were described by Verkhodanov & Trushkin (1994, 1995a,b), Verkhodanov et al. (1997, 2000a) and Trushkin et al. (2000). CATS allows one to operate with catalogs stored in ASCII and FITS Binary tables, to fit radio continuum spectra and to calculate spectral indices obtained from different radio catalogs. This database is located at the server \texttt{cats.sao.ru} under OS Linux.
Implementation of the database

The present database consists of catalogs, their descriptions and corresponding programs operating under OS Unix. The program codes are created in the “C” algorithmic language and translated with the GNU project C compiler. The codes are freely shared, provided they are used for non-commercial goals. The scheme of the CATS database is shown in Fig. 1.

New catalogs may be added to the system in conformity with the following rules:
1) every new catalog of objects should be placed in the UNIX directory with the same name as the catalog of objects;
2) the description of the catalog should also be placed in that directory;
3) the programs (or operating scripts) for local operations with the catalog of objects are also placed in the same directory;
4) brief characteristics, program names and description file of the astrophysical catalog are stored in the database of descriptions of catalogs named cats.descr.

The following information is stored in the database of the catalog descriptions cats.descr: the name of the catalog, which is coincident with the name of the UNIX directory, the type of the catalog (radio, optical, combined, etc.), frequency/wavelength range, minimum fluxes or magnitudes, equatorial or/and galactic coordinates, names of the local programs for the “select” and “match” functions (see below corresponding Section), the name of the document file, the number of records in the catalog, the size of the beam pattern or angular resolution, a recalibration factor (if available) to put catalog from an index prepared from a right ascension sorted list. It allows one to make efficient use of hard-disk seeking functions. To avoid the problems of searching within a few degrees at the poles when recalculation from one equinox to another one is done, we process total list of objects in these zones.

For catalogs in FITS Binary table format (e.g., NVSS or SDSS catalogs), special programs for the ‘select’ and ‘match’ functions were prepared.

To organize access of a local user of CATS from any directory of the OS, the operation programs that process the main CATS tasks are placed in a commonly accessible directory of the OS UNIX. The control procedures cats.sel and cats.match, organized as shell–scripts, cover all the low-level programs and provide the interface between CATS and a local user, or requests made via HTTP or e-mail. The detailed method of the catalog storage facilitates the database development, its expansion with new data and the possibility to tune the supporting programs.

CATS has its own indexing procedure cats.divide for object coordinates in a catalog. The program decides on where to start searching records of the input catalog from an index prepared from a right ascension sorted list. It allows one to make efficient use of hard-disk seeking functions. To avoid the problems of searching within a few degrees at the poles when calculation from one equinox to another one is done, we process total list of objects in these zones to find a required source. The indexing of CATS lists by declination is now under consideration.

The main functions

The following functions are currently implemented in CATS:

1. Selection of objects from one or several catalogs by the main parameters: equatorial or galactic coordinates, flux densities, spectral indices, frequencies, names, and (for some catalogs) the type of objects. Parameters common to all catalogs (coordinates and flux density) are used in selection.

2. Search for counterparts of objects (selected from one or several catalogs) by coordinate matching within the error box, circle, or ellipse.

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1 Proper motions are assumed to be zero
3. Cross-identification of different catalogs. This procedure is currently available only for local users. It uses the output from the selected zones of one catalog as input for the matching procedure on another catalog.

4. Preparation of receipt with a short description and characteristics of each catalog, printing of the total list of catalogs for the required sky areas (for local user).

5. Drawing radio spectra of selected sources. This can be done from multi-frequency catalogs, or catalogs prepared by the CATS team from cross-identification of radio catalogs at different frequencies, or even by individual user input of frequencies and flux densities for a source (at cats.sao.ru/~satr/SP/spectrum.html). This function is realized in two procedures. The first one is a JavaScript for homogenized CATS data format for single objects accessible from the web page. The second one is in the local data processing system FADPS for object lists.

The result of the object selection is a datafile sorted according to different object characteristics (right ascension (default mode), declination or frequency). This file can either be displayed on the standard output or sent to the user in the following formats:

1. The “native” (original) format of the catalog (i.e. columns as published); for guidance of the user a header with a very brief column description is added for each catalog that yielded output records.

2. Standard (“homogenized”) output format. This format is organized to be common for all the catalogs and used later for unification of data, preparation of spectra and statistical analysis. The standard FITS Table format describing data and fields of the table may be added as a header of the resulting file.

The result may then be used for subsequent investigation of the radio source spectra or statistical properties of objects in a flexible astronomical data processing system FADPS (Verkhodanov 1997) or, e.g. for the selection of distant objects in combination with redshift and age estimation with the system “Evolution of radio galaxies” (Verkhodanov et al. 2000b).

**Access to CATS**

Different modes of access are provided according to user requirements and CATS goals, following modern trends of software development. Thus, three main modes of on-line access to the CATS database have been prepared:

1. **Dialogue mode** (non-graphics) has been maintained until the present. Several scripts written in the UNIX shell language have been created (Verkhodanov & Trushkin 1994). They permit one to operate with the database supporting programs via TCP/IP and NFS protocols in the local computer network.

2. **Hypertext access** (http://cats.sao.ru) is provided to allow a user from the internet system to operate with the database CATS via hypertext transfer protocol. It allows one to execute all described operations from the Web-page.

3. **ftp access** (ftp://cats.sao.ru) allows a user to obtain both the description of CATS catalogs and...
the catalogs themselves. Here is an example of access by anonymous FTP to the catalog WISH:

\texttt{anonymous@ftp://cats.sao.ru}

\begin{verbatim}
ftp> bin
ftp> cd WISH
ftp> get wish11.cat
ftp> bye
\end{verbatim}

All the catalog names are stored in the file of descriptions \texttt{cats\_descr} (ftp://cats.sao.ru/cats\_descr).

4. **E-mail access** allows the user to send batch requests to CATS. One can send an e-mail with requests of matching with lists or selection by several parameters. The e-mail will be read automatically and sent for execution to the CATS scripts. The result will be sent back automatically to the user via e-mail.

**‘Select’ and ‘match’ procedures**

Two main procedures of data selection have been provided at different levels of the CATS control. They are the \texttt{select} and \texttt{match} tasks. They follow the first three main functions described above and are realized in different access modes. As was described earlier, the two low-level procedures \texttt{c\_sel} and \texttt{c\_match} provide information according to the corresponding user requests and pass it to the upper-level control scripts \texttt{cats\_sel} and \texttt{cats\_match}.

Using these two procedures the cross-identification of catalogs is possible by using the output from the ‘select’–function of the first complete catalog as the input of the ‘match’–function of the second catalog or catalogs.

**E-mail access**

In order to economize on the user’s real time and avoid the delays in on-line data exchange, we provide a possibility to submit a batch task in the form of an e-mail letter.

The e-mail requests may have several formats (as explained in a file that is returned on an empty e-mail to cats@sao.ru, with no subject). Two examples of the body of an e-mail (no subject required) are shown below.

- **selection task:**
  \texttt{mail -s "" cats@sao.ru}
  \begin{verbatim}
cats select
  ra min=10:30 max=10:40:00.
dec > 10' < 12' 30"
  flux > 0.5mJy
  catalogs r equinox=1950
  cats end
\end{verbatim}

- **matching task:**
  \texttt{mail -s "" cats@sao.ru}
  \begin{verbatim}
cats match
catalogs NVSS,FIRST
  window box x=30' y=10'
  sources:
  s1 02:02:00 +31:23:16 1950
  s2 02:23:10 34:03:00 1950
  s3 21:26:33.9 -18:34:33.0 1950
cats end
\end{verbatim}

These examples demonstrate the use of some keywords for batch requests (see the results of these requests in Tables 1 and 2). The beginning and the end of the request are defined by the statements: \texttt{cats start} and \texttt{cats end}. The first example shows how to search within certain limits of coordinates by using the (\texttt{min, max}) or (\texttt{<, >}) operators for right ascension (\texttt{ra}) and declination (\texttt{dec}). The keywords expression ‘\texttt{catalogs r}’ sets the type of catalogs to be used for selection, where ‘\texttt{r}’ means all the radio catalogs. Instead of ‘\texttt{r}’, one may choose ‘\texttt{o}’ for the optical catalogs, ‘\texttt{x}’ for the X–ray ones, ‘\texttt{ir}’ for the infrared ones, or just the names of used lists separated with comma (e.g. ‘\texttt{catalogs NVSS,FIRST,WISH}’). The keyword \texttt{epoch} sets the equinox of the input coordinates. ‘\texttt{Flux}’ sets flux limits.

The second example of the e-mail task is the matching procedure. There are some additional keywords ‘\texttt{window box x=30' y=10' }’, where ‘\texttt{Vbox}’ is the type of matching window (others are ‘\texttt{circle}’ and ‘\texttt{ellipse}’), ‘\texttt{x}’ and ‘\texttt{y}’ are horizontal and vertical coordinate directions, respectively. Note that \texttt{x} and \texttt{y} are half the side lengths of the search box, the value following the \texttt{circle} keyword is its radius, and those following the \texttt{ellipse} keyword are the semi-major and semi-minor axes of the ellipse. For the moment no

\footnote{The full list of the CATS catalogs can be obtained from the CATS Web-page \url{http://cats.sao.ru/doc/CATS\_list.html}}
Table 1: Example of an output returned upon a ‘select’ request. Columns are, respectively, the catalog name, the source name, the right ascension (hours, minutes and seconds of time) of the object, the error of RA (in time seconds) if available, otherwise ‘n’, the declination (degrees, minutes and seconds of arc), the error of declination (in arcseconds) if available, otherwise ‘n’, the frequency (MHz), the flux density (Jy), the error of flux density (Jy), the equinox (‘J’ means ‘J2000.0’, ‘B’ means ‘B1950.0’). Note that the names are based on J2000 coords. here, but the user-specified output equinox was B1950.0, causing RA and DEC to be different from those in the J2000-based names.

# TASK: select
# default input epoch: B1950.0
# default output epoch: B1950.0
# RA limits: 10:30:00.000 10:40:00.120
# Dec limits: 00:10:00.001 00:12:29.999
# GLon limits: 0 360
# GLat limits: -90 90
# Flux limits: 0.0005Jy 1000000Jy

| cat name   | RA     | eRA | Dec     | eDec | freq | Flux(Jy) | eFl equi. |
|------------|--------|-----|---------|------|------|---------|----------|
| FIRST J103242.4-000331 | 10 30 08.668 | n | +00 11 56.29 | n | 1400 | 0.01933 | 1.38e-04 B |
| NVSS J103242-000332 | 10 30 08.7 | 0.054 | +00 11 55.16 | 0.89 1400 | 0.0207 | 0.0005 B |
| NVSS J103343-000415 | 10 31 09.468 | 0.358 | +00 11 14.17 | 12.24 1400 | 0.0040 | 0.0006 B |
| NVSS J103352-000433 | 10 31 18.72 | 0.281 | +00 10 56.91 | 4.23 1400 | 0.0034 | 0.0005 B |
| FIRST J103413.2-000432 | 10 31 39.430 | n | +00 10 58.37 | n | 1400 | 0.0215 | 1.47e-04 B |
| FIRST J103413.2-000442 | 10 31 39.465 | n | +00 10 48.12 | n | 1400 | 0.00735 | 1.46e-04 B |
| FIRST J103413.2-000453 | 10 31 39.502 | n | +00 10 36.85 | n | 1400 | 9.9000e-04 | 1.46e-04 B |
| NVSS J103413-000436 | 10 31 39.507 | 0.042 | +00 10 54.34 | 0.73 1400 | 0.0317 | 0.0005 B |
| FIRST J103748.6-000515 | 10 35 14.872 | n | +00 10 20.65 | n | 1400 | 0.01031 | 1.48e-04 B |
| FIRST J103749.3-000522 | 10 35 15.577 | n | +00 10 14.02 | n | 1400 | 0.0038 | 1.48e-04 B |
| NVSS J103749-000521 | 10 35 15.601 | 0.052 | +00 10 14.49 | 0.81 1400 | 0.0320 | 0.0014 B |
| FIRST J103750.1-000525 | 10 35 16.372 | n | +00 10 10.34 | n | 1400 | 0.01009 | 1.48e-04 B |
| FIRST J103846.6-000316 | 10 36 12.838 | n | +00 12 21.62 | n | 1400 | 0.00132 | 1.38e-04 B |
| NVSS J103749-000521 | 10 35 15.601 | 0.052 | +00 10 14.49 | 0.81 1400 | 0.0320 | 0.0014 B |
| FIRST J103750.1-000525 | 10 35 16.372 | n | +00 10 10.34 | n | 1400 | 0.01009 | 1.48e-04 B |
| FIRST J103846.6-000316 | 10 36 12.838 | n | +00 12 21.62 | n | 1400 | 0.00132 | 1.38e-04 B |
| NVSS J103950-000324 | 10 37 16.805 | 0.598 | +00 12 14.43 | 5.87 1400 | 0.0038 | 0.0011 B |
| NVSS J104008.9-000353 | 10 37 35.191 | 0.777 | +00 11 45.81 | 1.27 1400 | 0.0134 | 0.0005 B |
| FIRST J104220.5-000409 | 10 39 46.783 | n | +00 11 33.46 | n | 1400 | 0.00103 | 1.41e-04 B |

The catalogue identifications listed are related to the following references:

# FIRST : 1997ApJ...475..479White+ FIRST survey catalogue at 1.4GHz
# NVSS : 1998AJ....115.1693Condon+ 1996: NVSS survey catalog
Table 2: Example of output data returned upon a ‘match’ request. The first 14 columns correspond to the columns of the Table 1. Other columns are, respectively, the distance from the search position (in arcsec), the position angle (in degrees from N through E) of the radius vector connecting the search center with the object.

# TASK: match
# Search box 30 x 600 arcsec
# default input epoch: J2000.0
# default output epoch: J2000.0
#
# cat name RA eRA Dec eDec freq Flux(Jy) eFl equi.dist," pa,"
#-------------------------------------------------------------------------------------------------
#OBJECT: s1 02:02:00 +31:23:16 1950
WENSS WNB0202.5+3124 02 05 29.585 n +31 39 07.7 n 325 0.077 .0036 J 453.9 282
NVSS J020529+313912 02 05 29.738 0.071 +31 39 12.15 0.98 1400 0.0170 .0005 J 456.7 282
#
#OBJECT: s2 02:23:10 34:03:00 1950
NVSS J022526+341006 02 25 26.717 0.374 +34 10 06.63 3.85 1400 0.0037 .0005 J 664.4 125
NVSS J022529+342450 02 25 29.186 0.412 +34 24 50.47 5.6 1400 0.0030 .0007 J 716.3 46
WENSS WNB0223.1+3408 02 26 10.154 n +34 21 30.7 n 325 3.678 .00 45 J 301.8 1
GB6 J0226+3421 02 26 10.2 0.5 +34 21 25 8 4850 1.628 .145 J 296.1 1
NVSS J022610+342430 02 26 10.337 0.036 +34 24 30.31 0.56 1400 2.8949 .0005 J 301.4 0
NVSS J022649+340740 02 26 49.391 0.349 +34 07 40.85 4.2 1400 0.0034 .0006 J 715.4 222
#
#OBJECT: s3 21:26:33.9 -18:34:33.0 1950
NVSS J212840-183008 21 28 40.07 0.272 -18 30 08.45 6.54 1400 0.0039 .0006 J 788.5 228
NVSS J212840-181420 21 28 40.26 0.306 -18 14 20.93 3.08 1400 0.0048 .0005 J 722.6 306
NVSS J212840-182926 21 28 40.26 0.537 -18 29 26.22 6.54 1400 0.0034 .0006 J 759 230
NVSS J212841-181322 21 28 41.531 0.299 -18 13 22.25 5.09 1400 0.0049 .0006 J 744.6 310
NVSS J212855-181737 21 28 55.425 0.035 -18 17 37.7 0.78 1400 0.1092 .0040 J 433.3 301
NVSS J212859-182153 21 28 59.241 0.038 -18 12 53.21 0.65 1400 0.0462 .0018 J 600 328
NVSS J212921-182122 21 29 21.414 0.032 -18 21 22.99 0.56 1400 1.4124 .0005 J 0.3 337
NVSS J212945-182052 21 29 45.696 0.112 -18 20 52.35 1.61 1400 0.0089 .0005 J 346.9 85
NVSS J212950-181500 21 29 50.726 0.387 -18 15 00.03 5.15 1400 0.0032 .0005 J 566.6 47
NVSS J212952-182910 21 29 52.722 0.045 -18 29 10.27 0.7 1400 0.0372 .0015 J 645.2 136
#
#The catalogue identifications listed are related to the following references:
#--------------------------------------------------------------
# GB6 : 1996ApJS..103..427Gregory+ The GB6 catalog;;
# NVSS : 1998AJ....115.1693Condon+ 1996: NVSS survey catalog (updated! - v.40, Jul-02);
# WENSS : 1997A&A...124..259Rengelink+ The Westerbork Northern Sky Survey (WENSS).
position angle (PA) of the search ellipse may be given, and PA = 0° is assumed (i.e. semi-major axis along the N–S direction). The keyword ‘sources:’ shows that the following records separated by a newline code are source coordinates to be used for the matching procedure. Each record contains the name of an object, its equatorial coordinates (R.A. and Dec.) and the corresponding equinox.

Keywords in the batch request may be separated by a space, a tabulation or newline character.

The full information about the keywords and formats can be requested with an empty e-mail to the address cats@sao.ru (no subject required).

Results of these two sample requests are shown in Tables 1 and 2.

The main catalogs
The major source of radio catalogs of CATS is the collection of one of us (Andernach 1990, 1999), who has spent large efforts to recover older source lists not previously available in electronic form, using a scanner and optical character recognition software. This collection is complemented in several ways: contributions from authors, astro-ph preprints, tables from electronic journals and the CDS catalog archive, as well as occasional manual retyping of the original catalog. About 70 catalogs have been typed and/or corrected manually at SAO RAS by S.Trushkin. The largest catalogs (e.g. NVSS, FIRST, SDSS, etc.) were copied from Web-sites of the catalog authors.

CATS is mainly a radio-astronomical database. All major catalogs incorporated into CATS are shown in Tables 3 and 4 (adapted and updated from Table 1 of Andernach 1999).

| Freq. (MHz) | Name      | Year of publ. | RA (h) | Dec (°)  | HalfPower BeamWidth (arcmin) | $S_{min}$ (mJy) | Number of objects |
|------------|-----------|---------------|--------|----------|-------------------------------|-----------------|------------------|
| 10-25      | UTR-2     | 78-95         | 0-24   | >-13     | 25.60                         | 10000           | 1754             |
| 38         | 8C        | 90/95         | 0-24   | +60      | 4.5                           | 1000            | 5859             |
| 74         | VLSS      | 2004          | 0-24   | -30      | 1.3                           | 350             | 32521            |
| 80         | CUL1      | 73            | 0-24   | -48,+35  | 3.7                           | 2000            | 999              |
| 80         | CUL2      | 75            | 0-24   | -48,+35  | 3.7                           | 2000            | 1748             |
| 82         | IPS       | 87            | 0-24   | -10,+83  | 27x350                        | 500             | 1789             |
| 151        | 6Cl       | 85            | 0-24   | <+80     | 4.5                           | 200             | 1761             |
| 151        | 6ClI      | 88            | 8.5-17.5 | +30,+51  | 4.5                           | 200             | 8278             |
| 151        | 6ClII     | 89            | 5.5-18.3 | +48,+68  | 4.5                           | 200             | 8749             |
| 151        | 6ClIV     | 91            | 0-24   | +67,+82  | 4.5                           | 200             | 5421             |
| 151        | 6ClVa     | 93            | 1.6-6.2 | +48,+68  | 4.5                           | 300             | 2229             |
| 151        | 6ClVb     | 93            | 17.3-20.4 | +48,+68  | 4.5                           | 300             | 1229             |
| 151        | 6ClVI     | 93            | 22.6-9.1 | +30,+51  | 4.5                           | 300             | 6752             |
| 151        | 7CI       | 90            | (10.5+41) | (6.5+45) | 1.2                           | 80              | 1273             |
| 151        | 7ClI      | 95            | 15-19   | +54,+76  | 1.2                           | 100             | 2702             |
| 151        | 7ClII     | 96            | 9-16    | +20,+35  | 1.2                           | 150             | 5526             |
| 160        | CUL3      | 77            | 0-24   | -48,+35  | 1.9                           | 1200            | 2045             |
| 178        | 4C        | 65            | 0-24   | -7,+80   | 15x7.5                        | 2000            | 4844             |
| 232        | MIYUN     | 96            | 0-24   | +30,+90  | 3.8                           | 100             | 34426            |
| 325        | WENSS     | 98            | 0-24   | +30,+90  | 0.9                           | 18              | 229420           |
| 327        | WSRT      | 91            | 5 fields | (+40,+72) | 1.0                           | 3               | 4157             |
| 352        | WISH      | 2002          | 0-24   | -25,-9   | 0.9                           | 18              | 90357            |
| 365        | TXS       | 96            | 0-24   | -35.5,+71.5 | .1                          | 250             | 66841            |
| 408        | MRC       | 81/91         | 0-24   | -85,+18.5 | 3                             | 700             | 12141            |
| 408        | B2        | 70-73         | 0-24   | +24,+40  | 3x10                         | 250             | 9929             |
| 408        | B3        | 85            | 0-24   | +37,+47  | 3 x 5                        | 100             | 13354            |
| 608        | WSRT      | 91            | sev.fields | (40,72) | 0.5                           | 3               | 1693             |
| 611        | NAIC      | 75            | 22-13  | -3,+19   | 12.6                         | 350             | 3122             |
| 843        | SUMSS     | 99            | 0-24   | <+30     | 0.72                         | 6               | 178975           |
| 1400       | GB        | 72            | 7-16   | +46,+52  | 10x11                        | 90              | 1086             |
| 1400       | GB2       | 78            | 7-17   | +32,+40  | 10x11                        | 90              | 2022             |
| 1400       | WB92      | 92            | 0-24   | -5,+82   | 10x11                        | 150             | 31524            |
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Names of catalogs contained in CATS with corresponding references are presented in Appendix.

CATS also contains observational and combined catalogs of Galactic supernova remnants (e.g., Trushkin et al. 1987; Trushkin 1996), secondary tables with objects selected by spectral index (Chambers et al. 1996; Röttgering et al. 1994; De Breuck et al. 2000), variability or AGN properties (Kovalev et al. 1999, 2000). Also the database includes source catalogs obtained from cross-identifications performed within CATS (IRAS–TXS: Trushkin & Verkhodanov (1995) and Verkhodanov & Trushkin (2000); UTR\_ID: Verkhodanov et al. (2000c, 2003); WMAP: Trushkin (2004)).

Examples of some typical tasks

- **Extraction of a sample of steep-spectrum radio sources from the FIRST catalog.**

To execute this task, one may use the FIRST (1400 MHz) and Texas (365 MHz) catalogs selection in a given zone. The FIRST and Texas catalogs have a flux density limit of about 1 and 150 mJy, respectively. A cross-matching of objects in any sky zone where these two catalogs overlap will return sources with the required properties. Thus, we prepare 2 requests: (1) select all objects from a given zone in the FIRST catalog with the ‘select’–function, (2) using the list of FIRST sources obtained in (1) we cross-identify selected objects with the Texas data with the ‘match’–function. The resulting list can be used to finish the required selection in the given zone.

- **Identification of objects with optical catalogs in CATS.**

Open the CATS web page with optical catalogs, and provide the input list of objects. Alternatively, select ‘catalogs o’ in your e-mail request, provide a list of objects of interest, and send the request.

Summary

CATS provides a simple and convenient access to astrophysical data and complements the data available from other services, most notably for radio continuum flux densities, for which it is the largest database in existence. Operation with the database permit astronomers to search for peculiar objects and study physical processes in sources of cosmic radiation.

Until October 2004, we registered over 28000 requests for the ‘select’ or ‘match’ procedures, which

| Freq. (MHz) | Name | Year of publ. | RA (h) | Dec (°) | HalfPower BeamWidth (arcmin) | Number of objects |
|------------|------|--------------|--------|--------|-------------------------------|------------------|
| 1400       | NVSS | 98           | 0-24   | -40, +90 | 0.9                          | 2.0              |
| 1400       | FIRST | 98           | 7.3, 17.4 | 22.2, 57.6 | 0.1                          | 1.0              |
| 1400       | PDF  | 98           | 21.3, 3.3 | -11.5, +1.6 | 0.1-0.2                      | 0.1              |
| 1500       | VLNEP| 94           | 17.4, 18.5 | 63.6, 70.4 | 0.25                         | 0.5              |

Names of catalogs contained in CATS with corresponding references are presented in Appendix.

CATS also contains observational and combined catalogs of Galactic supernova remnants (e.g., Trushkin et al. 1987; Trushkin 1996), secondary tables with objects selected by spectral index (Chambers et al. 1996; Röttgering et al. 1994; De Breuck et al. 2000), variability or AGN properties (Kovalev et al. 1999, 2000). Also the database includes source catalogs obtained from cross-identifications performed within CATS (IRAS–TXS: Trushkin & Verkhodanov (1995) and Verkhodanov & Trushkin (2000); UTR\_ID: Verkhodanov et al. (2000c, 2003); WMAP: Trushkin (2004)).

Examples of some typical tasks

- **Extraction of a sample of steep-spectrum radio sources from the FIRST catalog.**

To execute this task, one may use the FIRST (1400 MHz) and Texas (365 MHz) catalogs selection in a given zone. The FIRST and Texas catalogs have a flux density limit of about 1 and 150 mJy, respectively. A cross-matching of objects in any sky zone where these two catalogs overlap will return sources with the required properties. Thus, we prepare 2 requests: (1) select all objects from a given zone in the FIRST catalog with the ‘select’–function, (2) using the list of FIRST sources obtained in (1) we cross-identify selected objects with the Texas data with the ‘match’–function. The resulting list can be used to finish the required selection in the given zone.

- **Identification of objects with optical catalogs in CATS.**

Open the CATS web page with optical catalogs, and provide the input list of objects. Alternatively, select ‘catalogs o’ in your e-mail request, provide a list of objects of interest, and send the request.

Summary

CATS provides a simple and convenient access to astrophysical data and complements the data available from other services, most notably for radio continuum flux densities, for which it is the largest database in existence. Operation with the database permit astronomers to search for peculiar objects and study physical processes in sources of cosmic radiation.

Until October 2004, we registered over 28000 requests for the ‘select’ or ‘match’ procedures, which
Table 4: Some catalogs of other wavelength ranges in the CATS

| Scheme | PGC Publ | RA   | Dec    | Number |
|--------|----------|------|--------|--------|
| opt    | PGC 89   | 0-24 | -90,+90 | 73197  |
| opt    | MCG 75   | 0-24 | -33.5,+90 | 31886  |
| opt    | MSL 85   | 0-24 | -90,+90 | 181603 |
| opt    | SDSS DR2 2004 | several | Gals: 216906 |
| ir     | IRASPSC 87 | 0-24 | -90,+90 | 245889 |
| ir     | IRASFSC 89 | 0-24 | | 31886 |
| ir     | IRASSSC 89 | 0-24 | -90,+90 | 43886  |
| ir     | 2MASS 2000 | 0-24 | -90,+90 | 740992970 |
| Xray   | ROSAT 95 | 0-24 | -90,+90 | 74301  |
| mix    | QSO HB2 93 | 0-24 | -84,+86 | 7315   |
| mix    | VERON+11 93 | 0-24 | -83,+85 | 48921  |

are the most popular. The most popular catalogs for FTP-copying over the last five years are QSO by Hewitt & Burbidge (20 times), PGC (19 times), and NVSS (18 times). CATS processes daily up to 1000 HTTP–requests for information concerning the catalog descriptions.

CATS is being expanded continuously and presently comprises more than 400 catalogs including all the RATAN–600 catalogs. The database in its present form occupies about 60 Gb of disk space.

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Appendix

UTR-2  Braude et al. (1978, 1979, 1981, 1985, 1994, 2002);
8C     Hales et al. (1995);
VLSS   Lane et al., (2004);
CUL1,2,3  Slee et al. (1995);
IPS    Purvis et al. (1987);
6C     Baldwin et al. (1985), Hales et al. (1988, 1990, 1991, 1993a,b, 1995);
7C     McGilchrist & Riley (1990), Visser et al. (1995), Lacy et al. (1995),
       Waldram et al. (1996), Pooley et al. (1998), Riley et al. (1999a,b);
4C     Gower et al. (1967);
MIYUN  Zhang et al. (1997);
WENSS  Rengelink et al. (1997);
WSRT   Valentijn et al. (1977), Goss et al. (1977, 1980), Wouterloot & Dekker (1979),
       Habing et al. (1982), Isaacman (1981), Matthews & Spoelstra (1983),
       Oort & Windhorst (1985), Wieringa (1991), Roland et al. (1990), Taylor et al. (1996);
WISH   De Breuck et al. (2002);
TXS    Douglas et al. (1996);
MRC    Large et al. (1991);
B2     Colla et al. (1970);
B3     Ficarra et al. (1985);
NAIC   Durdin et al. (1975), Lawrence et al. (1986);
SUMSS  Bock et al. (1999);
GB     Maslowski (1972), Machalski (1978), Rys & Machalski (1987);
WB92   White & Becker (1992);
NVSS   Condon et al. (1998);
FIRST  White et al. (1997)
PDF    Hopkins (1998), Hopkins et al. (1998);
VLANEPE Kollgaard et al. (1994);
PKS    Wright & Otrupcek (1990), Otrupcek & Wright (1991);
Z      Amirkhanyan et al. (1989);
RC     Parijskij et al. (1991, 1992);
Z2     Larionov et al. (1991);
MG1-4  Bennett et al. (1986), Langston et al. (1990), Griffith et al. (1990, 1991);
87GB   Gregory & Condon (1991);
GB6    Gregory et al. (1996);
PMN    Gregory et al. (1994), Wright et al. (1996);
NEK    Kassim (1988);
7C(G)  Vessey & Green (1998);
WSRTGP Taylor et al. (1996);
GPSR   Becker et al. (1994), Garwood et al. (1988), Helfand et al. (1992), Zoonematkermani
       et al. (1990);
RRF    Reich et al. (1990);
F3R    Fürst et al. (1990);
ADP79  Altenhoff et al. (1979)
GT     Gregory & Taylor (1986);
PGC    Paturel et al. (1989);
MCG    Kogovshvili (1982);
MSL    Dixon (1970, 1980), Dixon et al. (1981), with corrections from Andernach (1989) and
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SDSS DR2 Schneider et al. (2001, QSOs list), Abazajian et al. (2004);
IRASPSC Beichman et al. (1988): IRAS Point Source Catalog;
IRASFSC Beichman et al. (1988): IRAS Faint Source Catalog;
IRASSSC Beichman et al. (1988): IRAS Serendipitous Survey Catalog;
2MASS  Cutri et al. (2002);
ROSAT  White et al. (2000);
QSO HB  Hewitt & Burbidge (1993);
VERON+11 Véron-Cetty and Véron (2003).