

# Archiving and Databases

## The Future of Memory: Archiving Astronomical Information

The database equivalent of humans remembering their perceptions is the archive, where the basic measurements are stored, as raw or reduced measures. This is the foundation for all future work.

Currently the rapidly declining cost of digital storage and processing technologies are racing with the astronomer's rapidly increasing capabilities for obtaining digital data. Which will win? Which astronomical projects will not be done due to the cost of data storage and reduction?

There is currently no satisfactory long term digital storage medium, nothing with the long term stability of paper books or photographic plates. How does this unpleasant state of affairs affect our ability to remember our measurements? Certainly it raises the cost of maintaining a measure as something which can be remembered. The experience of the space agencies (e.g. NSSDC) is perhaps most pertinent here.

Given that there is a cost per bit per year for maintaining archival information, how do we decide what to keep, and for how long. How does one judge the value of the archive compared with other possible expenditures, such as a new instrument?

Given interconnected archive systems of enormous size how can the astronomer find that subset of data which addresses a particular scientific problem? Intelligent information retrieval techniques are required to permit this.

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## Storage Media and Archive Technology

Early data archival systems depended upon whatever tape media were available, hand-written experimenter notes, and whatever simple labels had been applied to the data itself to locate and identify datasets of interest. Current file management technologies offer computer searchable indices and automated data management, moving data among different classes of storage media in response to user needs and stated policies. Future systems, which can just now be glimpsed, will provide integrated, object oriented, storage management that seamlessly manages multiple media types. This paper will briefly survey some earlier systems, describe in some detail currently available media and file management technologies and their uses, and point the way toward the future.

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## Aladin: An Interactive Deep Sky Mapping Facility

Any astronomer, whether preparing observing runs or reducing data, requires access to various information concerning the objects under investigation, including data from several wavelengths. This information must be as quantitative as possible. This leads to the concept of developing simultaneous interactive access to sky surveys, initially at optical wavelengths, and to state-of-the-art information systems on all field objects.

In order to satisfy this requirement, the CDS (Centre de Données astronomiques de Strasbourg) is developing an 'Interactive Deep Sky Atlas' project: Aladin. The CDS has many years experience in managing astronomical catalogues and object-orientated astronomical data, as represented by the Simbad database. In the last six years, the

CDS has developed new software based on Unix C, object-orientated database techniques and client-server philosophy for this purpose.

The Aladin project aims to connect the data stored at CDS (catalogues and Simbad), which are continuously updated, to deep optical sky surveys pixel data. These pixel data are now available from different sources, as digitized photographic sky surveys, and will be obtained in the future from CCD sky surveys.

Aladin will be mainly dedicated to quantitative preparation of observations, verification of astronomical catalogues content, locally optimal astronomical and photometrical calibrations, and determination of optical counterparts for radio, infrared, ultraviolet, X-ray and gamma ray sources.

The software architecture of Aladin will be based on the client-server philosophy. Each set of stored data (catalogues, data contained in Simbad and pixel images) will be accessed through a dedicated server. Each external user will use a distributed software (the graphical interactive interface) connected to a general CDS data server through the network. The pixel data and the catalogues will be archived on a juke-box of optical discs.

A project report and a prototype (using digitized ESO-Schmidt plates of the Large Magellanic Cloud) are presently under development at the CDS. If accepted, this project will be funded by INSU and CNES in 1993.

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## **Client Server Access to the Simbad Database within the Aladin Project**

Aladin, the Deep Sky interactive Facility, is a new CDS project whose main concept is to give interactive access to sky surveys (starting with optical ones), and simultaneously to what is already known about the studied field objects (Paillou et al., 1993). A prototype of Aladin has been developed in 1993. In this prototype the user interface directly communicates with the Simbad database and with a set of catalogues extracted from the CDS catalogues archive, in a client/server mode.

The Input/Output functionality of the Simbad software possesses now a server mode. In this server mode Simbad exchanges with a client program. The client generates standard Simbad queries and communicates with the server over a network layer. Beside the Aladin prototype user interface, other clients such as a Graphical User Interface to the Simbad database are presently under development.

The design of the client/server communications between the Simbad software and the Aladin prototype user interface is an anticipation of what will be implemented between Simbad and the general CDS data server.

Because each server within Aladin will use a low level Simbad-like interrogation language, this design will also be implemented in the future for the communications between the different pieces of the Aladin software.

### **References**

Paillou, Ph., Bonnarel, F., Ochsenbein, F. and Crézé, M., 1993, this newsletter.

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## Pickles: a Wide-field Imaging Tool

The program Pickles was developed as an aid for HST observations using the Space Telescope Science Institute's Guide Star Catalogue which was generated from short exposure Palomar Schmidt plates. Pickles accepts input from certain catalogues on CDs and in the Pickles file format. Almost any database catalogue stored on almost any computer readable medium can be written into the Pickles format. Pickles then allows editing of the resulting catalogue (including adding stars and objects) and printing the results in tabular and graphical form at almost any scale an observer would require. Pickles' use as an HST observing tool will be demonstrated. Its utility as a general observing tool will also be demonstrated by following the discovery of Ryan's Star from June 1989 to the present where it is identified as Ryan's Starburst Galaxy. Pickles is a program developed for use on Apple Macintosh computers and runs on workstations supporting Macintosh emulators.

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## Digitized Sky Surveys and Data Compression

For working with digitized surveys of large parts of the sky, a powerful data compression is indispensable. The compression is accomplished in at least two steps: the information concentration (i.e. the decorrelation of the data) and the coding. For 'lossy' compression one more step, the removal of the noise, is to be introduced after the decorrelation.

It can be shown that there is an optimal transform for the information concentration; and for an image model which fits the typical properties of a sky survey, this is the H-

transform. The connections between data compression, adaptive filtering, H-transform and wavelet transforms are considered.

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## Databases for Radio/Optical Objects: Radio Stars, Extragalactic Radio Sources, and Intermediate Reference Stars

The main task of this work is to create a reliable base for studying linkage between optical and radio reference systems and estimating the regional features of optical systems.

There are three main sets of data compiled at the Kiev University Observatory and in the Institute of Applied Astronomy (Russian Academy of Science, St. Petersburg) within the framework of the linkage problem:

- 1) radio and optical astrometric positions for about a hundred radio stars;
- 2) radio and optical astrometric positions for about two hundred extragalactic compact radio/optical sources (ERS);
- 3) optical positions of 2575 reference stars up to 9 mag. in the fields with 238 ERS compiled from various catalogues as well as from the special program similar to that of CONFOR etc.
- 4) a database for the 12-14 mag. system of reference stars in the fields with radio sources (in preparation now).

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## The ROSAT All-Sky Survey X-ray Sources: Cross Correlations with Various Catalogues and their Identification

The Germany X-ray astronomy satellite ROSAT has completed the first all-sky X-ray and XUV survey with imaging telescopes. This contribution will deal with the results of a first preliminary analysis in which about 50,000 new X-ray sources were detected. Results from correlations performed with various catalogues in other wavelengths will be presented.

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## The Collection of the Wide-field Patrol Plates of the Astronomical Observatory of Odessa

Exposures of the stellar sky have been obtained in Odessa since 1945. Initially 1-, 2-, 3- and (since 1957) 7-camera astrographs were used. The last one is characterized by an exposure time of 0.5 hours and allows observations of a region of sky up to 80 degrees in declination and up to 30 degrees in right ascension with limiting magnitudes 12.5 in photovisual and 14.5 in photographic systems. 36 bright guiding stars located in the northern hemisphere are used which mark centres of the observational fields. Patrol exposures cover all parts of the sky from declination from 90 to -15 degrees. The total number of plates in the Odessa Collection is nearly 100,000.

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## The WG WFI Plate Database: Present Status

The preparation of a wide-field plates database, initiated in the Working Group on Wide-field Imaging, is in progress at the Institute of Astronomy in Sofia. The purpose of this project is:

- 1) to collect the available information for about 2 million wide-field plates (angular dimension  $> 1$  deg.) which are the result of the operation of more than 225 telescopes since the end of last century, and
- 2) to organize the data for the wide-field plates into a database with an on-line access through the international data networks.

Thus, a powerful tool for future research will be provided. By the middle of 1993 some 55 files with catalogues of wide-field plates, received from 12 observatories, have been prepared for merging into the database. As a result now it contains the data for more than 300,000 plates (about 60% of all plate catalogues available in computer-readable form at present). A database management system ORACLE, installed on a TELMAT TR 5000 computer, has been used to create and maintain the database.

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## Flare Stars Database

As a result of the long term monitoring observations (8500 hours effective observing time) with wide-field telescopes, more than 1500 flare stars (UV Ceti type variables) have been discovered in the Galaxy until now. A standard data-processing package of programmes for the existing catalogues of flare stars in computer readable form in the field of the stellar aggregates Pleiades, Orion M 42/43, Cygnus, Praesepe, Coma Berenices, in the Solar vicinity, as well as for the subcatalogues of flare stars from the General Catalogue of Variable Stars, subsequent Name-lists of Variable Stars and the New Catalogue of Suspected Variable Stars has been prepared. The programme package has been developed for personal computers IBM XT/AT, or compatible ones, in Turbo C 2.0++. It gives flexible environment for easier access to the data for the characteristics of the flare stars and the registered flare-ups, and the corresponding references.

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## Direct-Photography Observations with the 2 m RCC Telescope at NAO-Rozhen: Catalog of Plates and Archive-data Analysis

A computer-readable catalog of the direct-photography observations with the 2 m Ritchey-Chretien-Coude telescope of the National Astronomical Observatory at Rozhen is presented. The catalog contains the data (equatorial coordinates, object designation, photographic emulsion, band filter, plate dimensions, observation date and time, exposure time, estimation of seeing, observer and notes) for nearly 2000 plates obtained

since 1980 when the 2 m telescope started operating. The catalog of plates will be useful for those who are interested in the repeated use of observations from the Rozhen Observatory plate archive.

The data from the observations catalog have been analyzed in order to determine some characteristics of the plate archive, which may be of interest for the potential user, as the distribution of the number of plates or the pure exposure time in dependence on: the time (year, month), the object type, the spectral band, the photographic emulsion type, the seeing, etc. The catalog data have also proved very useful for the determination of the periods (months) of the year with most favourable observational conditions (high number of clear nights and good seeing) at the Rozhen Observatory site.

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## The Photographic Catalogue of 55000 Stars in the Declination Zone from -16 to -30 Degrees obtained from Observations with the 40cm Astrograph of Hissar Astronomical Observatory, Tadjikistan

In 1977 at Pulkovo Observatory the work for the creation of the Catalogue of southern stars was started. It received later the name FOCAT-S. A little later to this work was joined the Astrophysical Institute of Tadjikistan at Dushanbe (which undertook the zone from -16° to -30° on declination).

In 1985 the first results were obtained at Tadjikistan. 840 plates were observed and a preliminary Catalogue was formed. Now the observational part of the work is finished. The reduction will be made at the Pulkovo Observatory using modern computers.

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## The Plate Archive of the Tautenburg Schmidt Telescope

The poster will first show some details on the world's largest Schmidt telescope at the Thüringer Landessternwarte Tautenburg. (Free diameter 134 cm, spherical primary mirror 200 cm, focal length 400 cm, field of view 3°3 x 3°3).

Then some information on the plate archive will be given. Since 1960 more than 8300 plates have been taken with this telescope. The most important data of these have already been available in computer-readable form since 1983.

Many original plates were loaned to astronomers all over the world. In accordance with the aims of the WFI working group we hope to recover some "lost" plates to our archive. The IAU-Symposium in Potsdam should allow the possibility to retrieve such plates.

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## The Harvard College Observatory Plate Collection

The collection of astronomical plates at the Harvard College Observatory contains of the order of 500,000 plates taken between 1885 and 1989 (with a gap in the 1950s and 1960s). The majority of these are direct blue plates, taken with a variety of refractors having focal scales of 60 – 600 arcsec/mm. For objects having blue magnitudes of 15 or brighter, normally from several hundred to a thousand or more images can be found in the collection; for those with blue magnitudes of 17, from a few to a hundred or more images can be located. The limit of the best plates is near 18 in the blue. Coverage is excellent in both hemispheres of the sky, with the southern hemisphere having perhaps the advantage.

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## The Wide-field Plate Archives Data Base in Latin America

During the creation of the Working Group on Wide-field Imaging of the IAU Commission 9, it was unanimously agreed that one of the most important tasks of the new WG would be the creation of a computer-readable Data Base, with the existing wide-field plate archives and all astro-photo plates obtained from the end of last century until now. Latin America has an important collection of plates from several Observatories.

The preparation of a list of wide-field plate archives is a necessary first step for the creation of the future data base. The second step is to computerize the data base for individual plates in plate archives. The third step consists of establishing a Data Bank with digitized wide-field plates. In this way, we wish to describe the up-to-date status of the project in Latin America.

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## The Sonneberg Observatory WFPA Database

We report on the database of the 250,000 plate archive of the Sonneberg Observatory: contents, structure, instructions for the user. The database will be included in ADS.

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