

RETRIEVAL TECHNIQUES AND GRAPHICS DISPLAYS USING A COMPUTERIZED
STELLAR DATA BASE

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ABSTRACT

A computerized astronomical data retrieval system, based on the Goddard Cross Index of star catalogs and operable from a remote terminal, has been developed. It permits retrieval of stellar data as a function of the object's identification numbers, descriptive parameters (magnitude and/or spectral type), or position in the sky. In addition, software has been developed to retrieve the full data entry from any of the eleven catalogs currently included in the Goddard Cross Index, such as the Yale Bright Star Catalog (YBS), the Boss General Catalog (GC), and others---all in one computer run.

Four catalogs (Smithsonian Astrophysical Observatory Star Catalog (SAO), The Revised New General Catalogue of Non-stellar Astronomical Objects (RNGC), Reference Catalogue of Bright Galaxies, and Two-Micron Sky Survey) have been sorted by Palomar Sky Survey plate area and precessed to the epoch of the specific plate. For any set of coordinates covered by the Palomar Survey and the Whiteoak Extension, the computer can provide all the plate numbers on which the position can be found. These plate areas can be immediately accessed by computer; listings or plots to any desired scale of any or all of the objects from the four catalogs can be provided.

I. INTRODUCTION

During the past several years a large number of important stellar catalogs have been put into machine-readable form by various groups. A user can thus search by computer any of these star catalog tapes to obtain the data required for his observing program or theoretical study. To do this, he must know the catalog identification (ID) number such as Henry Draper (HD) or Durchmusterung (DM) number, or position in order to select objects from each catalog. He must know how the catalog is sequenced, for what epoch the positions are given, and the format of each record. He must be sure the tape is adapted to his computer and that it is blocked in an efficient manner for rapid processing of the data.

Becoming familiar with each star catalog tape can be a time-consuming and frustrating task. It would be much more efficient to give the computer a list of ID's in the system of any machine-readable catalog, or a position, or a range in spectral type and/or magnitude, and obtain the available data from any or all of the catalogs. The development of such retrieval techniques and graphics displays using a computerized stellar data base at the NASA/Goddard Space Flight Center will be described in this paper.

II. CAPABILITIES OF THE GODDARD DATA RETRIEVAL SYSTEM

The current Goddard data base consists of 28 machine-readable astronomical catalogs. Eleven of these catalogs have been combined into the Goddard Cross Index (GCI), which serves as the computer entry point to these catalogs. A more complete description of the GCI is given by Underhill, Mead and Nagy in this volume.

Below are some examples of how this data base and retrieval system are being used:

- A. Star catalog lookup or retrieval: A random set of HD numbers can be entered into the computer; they are first sorted by ascending HD. These HD's are then matched against HD's in the GCI, from which the YBS and GC numbers are pulled, where available. These YBS and GC ID's are then sorted in ascending order and matched against each catalog (YBS and GC) to provide the data listing from the respective catalog for the original list of HD stars---all in one computer run.
- B. Preparation of candidates for observation by searching the data base for stars with given characteristics, such as location in a certain part of the sky, or having a brightness greater than a given magnitude, or falling within a given spectral type range. It is also possible to select stars on the basis of two or more characteristics, such as unreddened B stars, or high velocity binaries.

- C. Identification of potential guide stars within a given field-of-view, including specification of angular separation from the target star plus magnitude and spectral class limitations. This is especially useful for helping to locate and track faint stars. It can also be used to anticipate bright stars in or near the camera or telescope field-of-view, which may cause problems due to scattered light (especially for spacecraft observations). We have found the Strasbourg Catalogue of Stellar Identifications (CSI) to be especially useful in this application since it contains over 400,000 stars.
- D. Generation of plots of all catalog stars in or near the telescope's field-of-view to scale of Palomar, other atlases, or to the telescope itself for use as observing charts or to aid in identifying unknown sources, such as x-ray sources. Four catalogs (Smithsonian Astrophysical Observatory Catalog, The Revised New General Catalogue of Non-Stellar Astronomical Objects, Reference Catalogue of Bright Galaxies, and Two-Micron Sky Survey) have been sorted by Palomar Sky Survey plate area (Lund, J. and Dixon, R., 1973) and precessed to the epoch of the specific plate, with x- and y- coordinates in mm computed for each object. For any set of coordinates covered by the Palomar Survey and the Whiteoak Extension, the computer can provide all the plate numbers on which the position can be found. These plate areas can be immediately accessed by computer; listings or plots to any desired scale of any or all of the objects from the four catalogs can be provided. Figure 1 is a Calcomp plot of 3 types of objects appearing on Palomar plate centered at $-18^{\circ}, 18^{\text{h}}06^{\text{m}}$. Plotted are 360 SAO stars (squares), 42 two-micron sky survey objects (diamonds) and 15 RNGC objects (circles). Target circle in lower right is 15' of arc in radius.

III. COOPERATION WITH NASA'S NATIONAL SPACE SCIENCE DATA CENTER (NSSDC)

The NSSDC, located at the Goddard Space Flight Center, is well-equipped for retrieval and distribution of data to users. The Laboratory for Optical Astronomy (LOA) group has worked closely with the NSSDC in developing our existing data base. After checking out a given machine-readable catalog, we deposit it with the NSSDC, which then handles the distribution of that catalog to other users. As soon as the first version of our computerized astronomical data retrieval system is fully operational we plan to deposit this with the NSSDC for processing of requests. As the Strasbourg Stellar Data Center services the French astronomers through a computer network centered at Meudon, it is expected the NSSDC will eventually service North American astronomers via a telephone-computer hookup at NASA/Goddard.

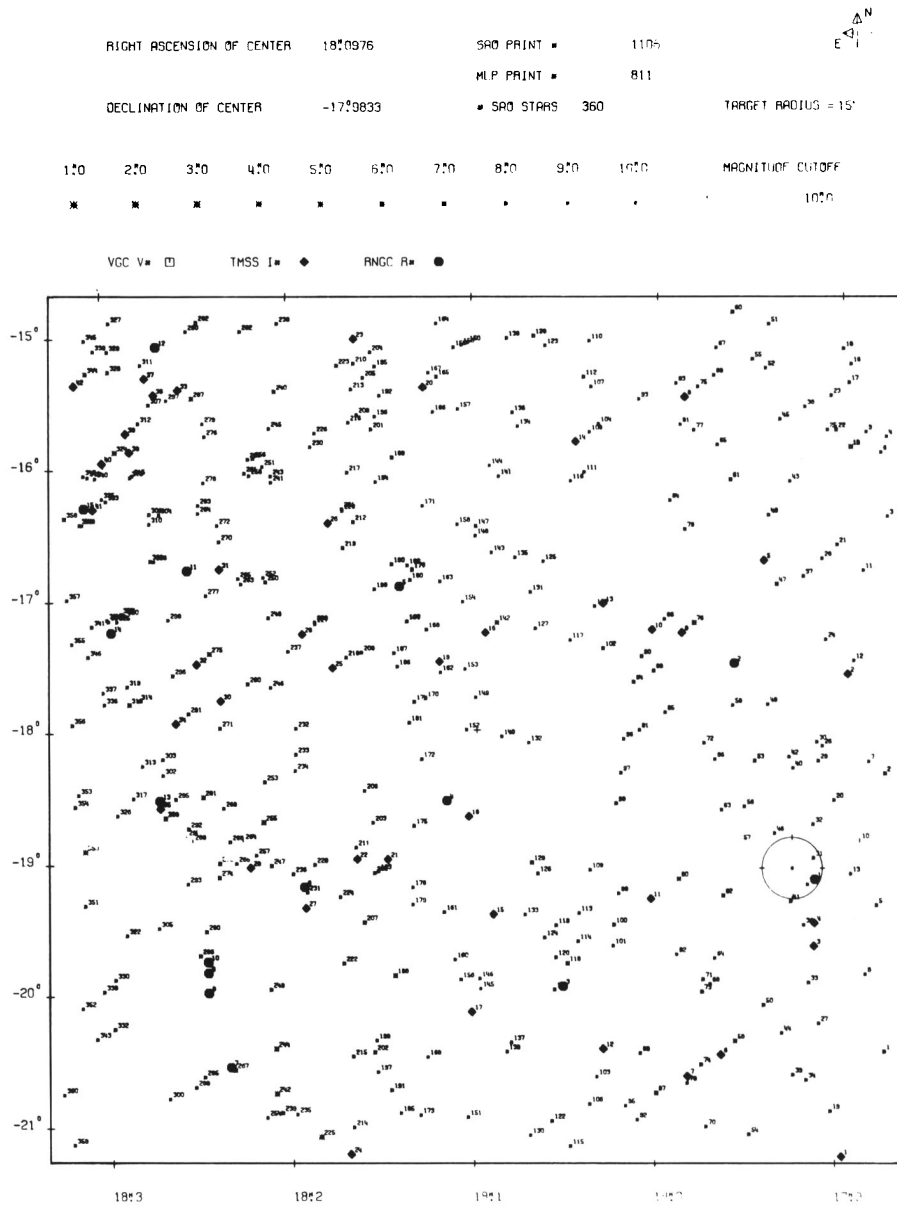


Figure 1 - Calcomp plot of 3 types of objects appearing on Palomar plate centered at $-18^{\circ}, 18^{\text{h}}06^{\text{m}}$. Plotted are 360 SAO stars (squares), 42 two-micron sky survey objects (diamonds) and 15 RNGC objects (circles). Target circle in lower right is 15' of arc in radius.

IV. INTERAGENCY COORDINATING COMMITTEE FOR ASTRONOMY - DATA TASK FORCE

The Interagency Coordinating Committee for Astronomy, which funds most of the astronomical research in the U.S., has requested, through its Data Task Force, that the NSSDC survey the American Astronomical Society membership to obtain information about available compilations of astronomical data. The first survey will be limited primarily to observational stellar and galactic data. Solar system data, laboratory measurements, and model results may be covered in later directories, if interest warrants this. A computer-oriented questionnaire has been prepared for mailing to anyone who wishes to describe his data files for inclusion in the directory. Respondents are encouraged to submit descriptions of both machine-readable and non-machine-readable data in any stage of completion. The information obtained will be keypunched for compilation into a fully indexed, loose-leaf Directory of Astronomical Data Files. Supplements will be issued to keep it current. The characteristics, or keywords, of each file will be machine-tabulated to permit searches by computer. The first edition will concentrate on North American data compilations. The goal is to help a user locate data sources keyed to his interests, along with enough descriptive information to permit him to assess the value of the files for his use as well as the status and availability of the compilations.

V. EXTENSION OF THE COMPUTERIZED DATA BASE

Appendix 1, Table of Nomenclature, from Kukarkin's Variable Star Catalogue has been keypunched at Wellesley Observatory and put on magnetic tape at Goddard. Since the Variable Star Catalog does not include HD or DM numbers, this cross index by variable star name and other ID's will be useful in providing definite identifications for these stars and will greatly facilitate their incorporation into our astronomical data base.

A magnetic tape version of the Cordoba Durchmusterung Catalog is being prepared at the NSSDC. This should prove useful in extending the completeness of the DM identifications in the southern hemisphere.

VI. SUMMARY

Astronomers using observational data can realize extensive benefits from the creation of a computerized astronomical data retrieval system through the sharing of a data base with its inherent expanded capabilities. Such an effort is being carried out at the NASA/Goddard Space Flight Center and the NSSDC through acquisition of star catalogs, development of retrieval techniques, and creation of a Directory of Astronomical Data Files. A program has been developed to retrieve with a single computer run the full data entry from any of eleven catalogs currently included in

the Goddard Cross Index of star catalogs. Graphics displays, such as Calcomp overlay plots, are available for four catalogs, sorted by Palomar plate area.

The Strasbourg Stellar Data Center is making an invaluable contribution in the field of stellar studies by collecting, combining and distributing computerized stellar data. Their services have been extended not only to French and other European astronomers, but on an international level as well. It is our hope that the National Space Data Center at the Goddard Space Flight Center will soon provide similar services in the retrieval of stellar data for North American astronomers. Our further goal is that the Strasbourg and Goddard groups may work together even more closely in the future as we both serve the needs of international astronomy.

REFERENCE

Lund, J. and Dixon, R. 1973, Publ. Astr. Soc. Pac. 85, 230.