THE ASTRONOMICAL DATA BASE AND RETRIEVAL SYSTEM AT NASA

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ABSTRACT

More than 250 machine-readable catalogs of stars and extended celestial objects are now available at the NASA/Goddard Space Flight Center (GSFC) as the result of over a decade of catalog acquisition, verification and documentation. Retrieval programs are described which permit the user to obtain from a remote terminal bibliographical listings for stars; to find all celestial objects from a given list that are within a defined angular separation from each object in another list; to plot celestial objects on overlays for sky survey plate areas; and to search selected catalogs for objects by criteria of position, identification number, magnitude or spectral type.

INTRODUCTION

There are two major objectives for the development of the astronomical data base and retrieval system at the NASA/Goddard Space Flight Center (GSFC): (1) the acquisition, verification and documentation of all available machine-readable catalogs of stars and extended celestial objects; and (2) the creation of retrieval techniques which will enable a user to utilize these data easily and efficiently from a remote terminal. More than 250 computerized astronomical catalogs are now available at GSFC. Periodically reports are published in the Astronomical Data Center Bulletin giving the status of verification, documentation and hence availability, for each catalog in the data base (Nagy et al. 1981b). Because the output of any retrieval system is only as good as the data base from which it obtains its information, much of our effort continues to be devoted to the improvement of the individual catalogs, as described by Warren et al. (1982).

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Three groups at Goddard are primarily responsible for the data handled by the Astronomical Data Center (ADC): the National Space Science Data Center (NSSDC); the Infrared Astrophysics Section of the Laboratory for Extraterrestrial Physics; and the Laboratory for Astronomy and Solar Physics, which also includes the newly established International Ultraviolet Explorer (IUE) Regional Data Analysis Facility.

The NSSDC, whose data responsibilities are reviewed by J. Vette (1981), serves as a distribution center for astronomical catalogs. The high-energy astrophysics data sets are described by M. Locke (1981). W. Warren Jr. is responsible for catalog data at longer wavelengths as well as archival and dissemination of observations from the IUE satellite (Warren and Alderman 1982).

The Infrared (IR) Astrophysics Section is committed to producing an IR (1-1000 μm) data base, bibliography and cross index of IR names as described by Schmitz et al. (1982).

The Laboratory for Astronomy and Solar Physics, with which T. Nagy, R. Hill and J. Mead are associated, does much of the verification and documentation of catalogs before they are placed with the NSSDC for distribution. The primary interest of this group is the creation and implementation of computerized retrieval systems described below.

The development of the data base and retrieval tools in a location where there is daily interaction with other astronomers promotes the familiarity of data personnel with the needs of both observers and theoreticians. It also encourages rapid evaluation of data products while providing many consultants on specialized astronomical and data handling topics.

ASTRONOMICAL DATA BASE

Part of the success in acquiring the large number of catalogs in the ADC data base is due to the Cooperative Agreement between NASA and the Centre de Données Stellaires (CDS), which was worked out as a by-product of the IAU Colloquium 35, held at Strasbourg in 1976. This agreement has also yielded the beneficial results of exchanges of error lists, personnel and information about future projects (Mead 1980; Mead et al. 1981).

Not all machine-readable catalogs received by the ADC are ready to be used. The first step in verification is to try to read the catalog as specified in the documentation accompanying it. This procedure quickly exposes most problems--if not in the machine-readable data, then sometimes in the format descriptions. Suggestions for formatting, checking and documenting machine-readable astronomical catalogs are given in detail by Hill (1981).

RETRIEVAL OF DATA

One of the most important aspects of a data base is its capability for efficient retrieval of the data. Six of the most frequently used astronomical data retrieval tools now available at the ADC are described below:

(1) The Interactive Computer Reference Search of the Astronomical Literature 1950-1976 (Nagy et al. 1981a) uses the data and reference files of the 1976 version of the Bibliographical Star Index (BSI) (Ochsenbein and Spite 1977). These data are stored on direct access devices on the GSFC IBM S/360-91 computer. The BSI is a machine-readable data file of stellar identifications and references covering twelve journals from 1950-1972 and more than 30 since then. Updated versions of this compilation are released periodically by the CDS. The machine-readable version available at Goddard contains 9494 references to the astronomical literature for 69,348 stars from 1950 partway through 1976; a later version of the BSI will be utilized as soon as the tape is received from the CDS.

The interactive BSI search program accesses the references by means of a star identifier (Henry Draper (HD) or Durchmusterung (DM) catalog number, or variable star name). The BSI references for the stars having these identifiers are then displayed at the user's computer terminal in a form resembling that of a standard bibliography. One advantage of this method of accessing the BSI lies in the conciseness of the output: only one session at a data terminal is needed to produce a combined, chronologically-ordered listing of references from all the years covered in the BSI. Another advantage lies in the ease of use: one only has to type in the stellar identifications according to instructions displayed on the screen by the program.

A limited amount of computer time has been set aside for a pilot program to utilize the BSI search program. All astronomers have been urged to avail themselves of this opportunity to access the data set from their home institutions by telephone link. Many favorable reports have been received from users.

(2) The MATCH Program (Hill and Nagy 1981) finds all objects in a list within a user-defined angular distance of the positions of a set of target objects. This technique is particularly useful when one wishes to make identifications of objects observed at similar wavelengths or at very different ones, as often occurs when observing in a survey mode. In addition, this program serves as a useful check on catalog identifications which have been made through manual comparisons, and it provides guide star candidates for observing programs where the objects of interest are very faint and/or have poor positions. Catalogs which have been used in MATCH runs include the following combinations: the Two-Micron Sky Survey vs. the SAO Catalog; the General Catalogue of Variable Stars vs. the Equatorial IR Catalogue (EIC 2); and the Dearborn Observatory Catalogue of Faint Red Stars vs. the EIC 2.

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(3) The Job Control Language (JCL) Copy Program (Hill and Nagy 1980) facilitates the duplicating of star catalog tapes by supplying all the necessary JCL parameters, such as block size, density, record length, etc., requiring only a four-digit numerical code for the catalog to be entered. Not only is this program time-saving in setting up tape copies, but it also reduces failures in the duplicating of tapes by automatically providing the information needed to copy the tape.

(4) Two search and retrieval programs have been developed (Warren and Sheridan 1981) for the Catalogue of Stellar Identifications (CSI) (Ochsenbein et al. 1977), which contains cross references for star numbers from some 30 different catalogs. Following the preparation of a version of the CSI sorted by increasing right ascension, a program was designed which accepts equatorial coordinate limits and lists all CSI stars located within the specified region. This search mode is useful for selecting possible optical identifications for a list of sources which are detected at other wavelengths or which are variable.

A second search program accepts DM and HD catalog numbers and lists all CSI stars with the specified input identifiers belonging to any of the various catalogs connected to the CSI. Individual data sets are created and stored for each catalog desired, so that each one can be read by a subsequent program to retrieve data from the corresponding source catalog. Ideally, this retrieval system will develop into a tool by which data from any number of source catalogs can be selected in a single run through a link to the CSI.

(5) Five catalogs (SAO Star Catalog, Revised New General Catalogue of Non-Stellar Astronomical Objects, Reference Catalogue of Bright Galaxies, Two-Micron Sky Survey and CSI) have been sorted by Palomar (and ESO/SRC) Sky Survey plate areas, as described by Mead and Nagy (1977). For a given set of coordinates the computer provides all the plate numbers on which this position can be found. These plate areas can be immediately accessed, and listings and plots of any or all of the objects from the five catalogs generated.

(6) Software has been developed to retrieve the full data entry for HD stars from any of the eleven catalogs included in the Goddard Cross Index in a single computer run (Mead and Nagy 1977). Another cross index which has proved to be particularly useful is the HD-DM-SAO Cross Index (Nagy and Mead 1978).

CONCLUSION

The ADC is continuing to provide these and other data retrieval routines to GSFC astronomers and to the astronomical community on a request basis. With an upgraded Goddard computer available later this year, we expect to have more data sets on line, such as the CSI, in order to make interactive retrieval systems readily available to anyone who wishes to access data directly by dialing up the GSFC computer.

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