ASTRONOMICAL DATA BASES AND RETRIEVAL SYSTEMS

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Abstract

The status of the development of machine-readable stellar and extragalactic data bases is summarized, including several examples of astronomical applications using these data sets. The creation of a computerized bibliographical data base for cometary research is described.

Introduction

During the past five years the number of machine-readable catalogues of stellar and extragalactic data has increased greatly. The Laboratory for Astronomy and Solar Physics at Goddard had 28 such catalogues in computer format in 1976, whereas we have more than 250 today. At that time minimal software existed for accessing and searching those catalogues; today we have highly efficient routines which can search through a data set of a half-million stars in less than a minute.

With the advent of space-borne instruments, the coverage of the observed spectrum has broadened from the limited optical window available to ground-based telescopes to the expanded space view in the gamma-ray, x-ray, infrared, millimeter and radio regions. The influx of these data has resulted in the preparation of many new catalogues, usually on magnetic tape.

Along with access to more observational wavelengths has come the discovery of additional classes of objects, such as quasars, pulsars and gamma-ray and x-ray bursters. The desire to identify the optical counterparts of these objects has been a strong driver for computerized data bases in recent years.

Computerization of data from the time they are obtained, either with ground-based telescopes or from space, has increased greatly in recent years and thus contributed to expanding the amount of data available. Space-borne balloons and satellites are making automated surveys which yield large volumes of data--a mode of operation which had not been possible from the ground in such an efficient manner.

No longer does one hear the debate over whether or not the field of astronomy should have a computerized data base. As more and more users recognize the value of this resource in providing data files designed to fit their specifications, whether it be a well-known catalogue which they can access and rearrange as they wish, or a data file created to fit their particular requirements of position, magnitude and/or spectral type, the users recognize the two big advantages for them: (1) saving of time by having the data machine-readable and thus computer-accessible and processable and (2) broadening of their data resources through the opportunity to have their own specially designed subset culled from a much larger data file, which itself has been produced by combining many machine-readable catalogues.

The development of such computerized astronomical data resources has taken place primarily at the Centre de Donnees Stellaires (CDS) in Strasbourg (Jung, 1971) and within the Laboratory for Astronomy and Solar Physics (Nagy et al., 1980). These two groups have worked together under a U.S.-French Cooperative Agreement through which we have exchanged catalogues, error lists, plans and personnel (Mead, 1980). This interaction has been not only productive for both parties, but has enabled us to make our work highly complementary and also to avoid needless duplication of effort. The additional cooperation of the National Space Science Data Center at Goddard in providing distribution and other services has greatly enhanced the U.S. capability in this area.

Data Storage

As tape catalogues are acquired and processed here, each is assigned codes describing the status of the documentation, checkout and availability. A Status Report of the Machine-Readable Astronomical Catalogues Available at Goddard is issued twice a year (Warren et al., 1980).

Approximately twenty percent of our catalogues are now available on microfilm and/or microfiche. Plans include preparing more of them in this format. Users find this mode particularly convenient when data for only a few stars are needed since one can have immediate access to the data without using the computer, yet the physical storage required for a large number of catalogues in this form is minimal. This is a useful format for combined data from several catalogues since the data set can be tailored to suit a particular project.

Data Applications

Several types of applications using the current data base are described below:

(1) Duplication of machine-readable star catalogues and associated documentation on magnetic tape or in microform.

(2) Creation of overlay plots to the same scale as the Palomar Sky Survey, ESO/SRC Atlas of the Southern Sky or Lick Atlas. This is a frequently requested item which is often used by an observer who has obtained an object's approximate position by a satellite measurement in the x-ray or γ-ray regions. He wants to find an optical counterpart, if possible. In most cases the catalogued star base does not go faint enough to have recorded the object, so the observer turns to a photographic survey such as those listed above. Often his observed position is not highly precise and finding the most likely candidate among a field of faint unidentified stars can be formidable. By inputting his position to our Plate Assignment Program, the observer can find out which sky survey prints contain his object and then obtain a plot of the catalogued objects in the area.

(3) Use of the Data Base Retrieval System. The Goddard Cross Index, which contains the identification numbers for eleven catalogues (Mead and Nagy, 1977) can be used to retrieve data for a list of Henry Draper Catalogue numbers. The computer program supplies the corresponding identification numbers from these catalogues along with instream documentation for each catalogue plus the complete entry for four of the catalogues--all in a single run. We plan to expand this cross index capability, now that most of our machine-readable catalogues have been substantially upgraded, by incorporating the catalogues for which we receive the most requests.

(4) Special Searches. This includes requests for retrieval of data from individual catalogues in the Goddard data base. These requests tend to be more time-consuming than other data activities since they usually require special software. In general, we have responded most favorably to requests which have an end product that is likely to be useful to other members of the astronomical community in addition to the requester.

(5) Bibliographical Searches. Software has been written to search the binary version of the Bibliographical Star Index (Cayrel et al., 1974) and the associated reference data set, using a direct access device (Mead et al., 1980). This capability has been made available to any astronomer who wishes to dial up the Goddard IBM 360/91 computer from his remote terminal. The possibility of putting other data sets "on line" in a similar way is also being pursued.

(6) Infrared Data Base. In the area of the infrared, few stellar catalogues are available and even less bibliographical information. An extensive search of the literature beginning with 1960, for non-solar system objects in the 1-1000 μm range has been made to create an astronomical infrared data base (Schmitz et al., 1980). Included in this machine-readable compilation are the IR source name, position, bibliographic reference, aperture size, wavelength, IR flux, and comments for each observation. All identifications for IR objects which have been made in the literature are being recorded in an "Atlas of IR Source Names," to be included as an appendix to the catalogue.

Application of Bibliographical Survey Techniques to Cometary Data

Bibliographical catalogues are very useful tools for uncovering data in the literature which might be overlooked otherwise. Unless the object being searched is named in the title of a paper or in its keywords, one may not realize that a given article contains information on that object. This is especially true if the article covers several objects.

By making a bibliographical survey to tabularize the data in the texts of journal articles, one can make this information machine-readable and thus access the data more readily. As an example, we have made such a survey using the abstracts from this workshop. The purpose was to record each comet named, the technique used to observe it, the spectral range, the observatory where the observations were made, the aperture of the instrument used, comments where appropriate, the authors, and an assigned reference number (in order to locate the abstract or paper).

Table 1 gives the data compiled in this way; the associated references are in Table 2. If such a data set were online, one could immediately determine which of these papers he wished to consult further, according to his particular interests. By expanding this technique to the cometary literature in general, one could create a bibliographical data base which might save users much time in library searches and also make them aware of many more sources of cometary data. Other techniques already developed in stellar and extragalactic astronomy might be applied to create additional computerized data bases and retrieval systems for cometary data.

References

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Table 1

Comet Name	Technique	Sp. Range (μ)	Obs.	Ap.(m)	Comments	Authors	Ref.
Bowell	SP	0.30-0.55	LPL			Larson, Donn	80-03
Bowell	PG		LPL			Larson, Donn	80-03
Bradfield (1979l)	PTM	0.30-0.35	M. Kea	0.6	OH, NH	Millis, A'Hearn	80-01
Bradfield (1979l)	PTM				OH, C2	A'Hearn	80-05
Bradfield	SP	0.30-0.55	LPL			Larson, Donn	80-03
Bradfield (1979l)	SP				OH, C2	A'Hearn	80-05
Bradfield (1979l)	SP	0.11-0.31	IUE		H, C, N, O	Feldman	80-06
Bradfield (1979l)	S-P		IUE		OH	Millis, A'Hearn	80-01
Bradfield (1979l)	S-P		IUE		OH, C2	A'Hearn	80-05
Bradfield	PG		LPL			Larson, Donn	80-03
d'Arrest	SP					Wyckoff	80-04
Halley (1910)	PG		LOW			Giclas	80-09
Halley (1910 II)	PG					Rahe	80-10
Halley (1910 II)	SP					Rahe	80-10
Kobayashi-Berger-Milon	SP					Wyckoff	80-04
Kobayashi-Berger-Milon	PG		JOCR	0.4		Brandt	80-07
Kohoutek (1973f)	PG		JOCR	0.4		Brandt	80-07
P/Honda-Mrkos-Pajdusakova	PG		CF-HI	3.6		Halliday et al.	80-02
Schwassmann-Wachmann-1	SP	0.30-0.55	LPL			Larson, Donn	80-03
Schwassmann-Wachmann-1	PG		LPL			Larson, Donn	80-03
Seargent (1978m)	SP	0.11-0.31	IUE		H, C, N, O	Feldman	80-06
West	SP					Wyckoff	80-04
West (1976 VI)	SP	0.11-0.31	S. RKT		H, C, N, O	Feldman	80-06
West (1975n)	PG		JOCR	0.4		Brandt	80-07
West	PG	0.47-0.67				Gull	80-08

Table 2

80-01 Millis, R. L., A'Hearn, M. F., "Ground-Based Photometry of Comets in the Spectral Interval 3000 to 3500Å"

80-02 Halliday, I., McIntosh, B. A., Cook, A. F., "An Attempt to Observe an Anti-Tail for P/Honda-Mrkos-Pajdusakova in 1980"

80-03 Larson, S. M., Donn, B., "A Systematic Program of Cometary Spectroscopy"

80-04 Wyckoff, S., "Cometary Ground-Based Observational Techniques"

80-05 A'Hearn, M. F., "Correlated Ground-Based and IUE Observations"

80-06 Feldman, P. D., "Ultraviolet Spectroscopy of Comets Using Sounding Rockets, IUE, and Spacelab"

80-07 Brandt, J. C., "The JOCR Program"

80-08 Gull, T. R., "Narrow Passband Imagery of Comet West"

80-09 Giclas, H. L., "Photographic Observations of Comets at Lowell Observatory"

80-10 Rahe, J., "Existing Cometary Data and Future Needs"