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DOCUMENTATION FOR THE MACHINE-READABLE VERSION
OF THE
SAO-HD-GC-DM CROSS INDEX
VERSION 1983



DECEMBER 1983

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ABSTRACT

An updated and extended machine-readable version of the catalog is described in detail. In addition to the correction of all errors found since preparation of the original catalog (Morin 1973, Obs. de Meudon, unpublished), most of which resulted from misidentifications and omissions of components in multiple-star systems and missing Durchmusterung numbers (the common identifier) in the SAO Catalog, component identifications from the *Index of Visual Double Stars* (IDS) have been appended to all multiple SAO entries having the same DM numbers, and lower case letter identifiers for supplemental BD stars have been added. A total of 11,398 individual corrections and data additions has been incorporated into the present version of the cross index.

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SECTION 1 - INTRODUCTION AND PROCEDURE

INTRODUCTION

A *Table of Correspondences* among the numbering systems of the *Smithsonian Astrophysical Observatory Star Catalog* (SAO, Smithsonian Astrophysical Observatory Staff 1966), *The Henry Draper Catalogue* (HD, Cannon and Pickering 1918-1924), the *Albany General Catalogue* (GC, Boss 1937) and the various *Durchmusterung* catalogs (DM [BD, SD, CD, CPD] see Fernandez, Lortet and Spite 1983 for references) was prepared by Morin (1973) by computer cross-identification of SAO stars with the HD (via DM numbers) and the GC (via HD numbers). The SAO does not, however, distinguish among components of multiple stars and between primary or supplemental entries in the *Bonner Durchmusterung*; thus, there are often two (occasionally three) stars in the SAO having identical DM numbers. Since the cross index was prepared by computer, the HD and GC numbers were frequently assigned to the wrong components. The current version of the *SAO-HD-GC-DM Cross Index* remedies this problem and corrects as many other errors as we could find, plus a number of errors kindly forwarded to us by various SAO Catalog users.

This document describes the new version of the *SAO-HD-GC-DM Cross Index*. It is intended to provide a description of the procedures used to correct and augment the previous version and to enable users to read and process the data without problems or guesswork. The following section outlines the methods used to cross identify the stars and to add the component identifications. Section 2 provides a detailed description of the catalog format, while Section 3 contains information on the characteristics of the magnetic tape file. Miscellaneous remarks and bibliographical references are given in Section 4, and a sample listing of data records comprises Section 5. A copy of this document should be distributed with any machine-readable copy of the catalog.

PROCEDURE

As a first step, all SAO entries having duplicate DM numbers were selected from the SAO Catalog and written to a separate file. Using the SAO positions, separations and position angles were computed for all duplicate DM entries in all possible ways, e.g. A with respect to B and B wrt A (at this point, component letters had not been assigned). Multiple systems were then identified in the *Index Catalogue of Visual Double Stars* (IDS, Jeffers et al. 1963; Worley 1980) and component identifications assigned according to that catalog. For stars not in the IDS, components were labeled according to visual magnitude. Supplemental BD stars were identified by cross indexing to the catalog of Warren and Kress (1980) and confirming with SAO and precessed BD positions. A few duplicate DM numbers actually referred to the same star for which SAO data had been obtained from different source catalogs. In these cases, cross references were deleted for one entry, normally for the one whose position was judged to be less accurate in the SAO. However, the data records have been retained and the deleted entries (blank data) indicated by placing

a "D" immediately following an SAO number. A similar procedure was followed for stars whose entries have been deleted in the SAO Catalog itself.

In the southern hemisphere, many stars occur in two DM catalogs (CD, CPD). For some double stars, the SAO gives the numbers from different catalogs for the two components; thus, for these stars, there are no duplicate DM numbers, but the same component confusion can occur. Although a search for such systems was not exhaustive, the catalog was searched for adjacent entries with numbers from DM catalogs and declinations within 3' of each other. Most of these proved to be double stars and were labeled with letter designations as if they had had the same DM numbers, i.e. the DM numbers were not changed, but the letter designations for the components were merely added.

Once the components of double and multiple systems had been correctly identified, the HD and GC catalogs were checked manually to be certain that the correct numbers in these catalogs were assigned to each component. The catalog was then scanned visually for HD and GC numbers which appeared to be out of order. In this way, a number of cases of confusion between numbers in the southern catalogs was found and corrected. The HD and GC numbers were corrected appropriately for double-star components.

An important subset of rather bright stars in the published SAO Catalog has no DM numbers given. (Most of the stars in this subset were identified as FK3 double stars which were omitted from FK4.) Many of these stars had been identified by W. L. Stein, who supplied probable DM numbers. The positions for these stars were compared manually with their positions in the various DM catalogs and many additional identifications were made.

Although the *Henry Draper Extension* (HDE, Cannon 1925-1936) stars from *Harvard Annals*, Volume 100, having DM numbers listed in the original catalog, were included in the Cross Index, those listed with AG numbers only (Astronomische Gesellschaft, zones +50° to +54°, Harvard, Rogers 1892; zones +55° to +59°; Helsingfors-Gotha, Krüger 1890) had not been cross identified to the SAO. The *Yale Zone Catalogues* (YZ, Barney et al. 1959, 1959a) which identify stars by their AG numbers, but also give corresponding DM numbers, were used to cross identify the AG stars. This was accomplished by using the magnetic tape versions of the YZ and HD catalogs and matching the stars by machine. A cross index of *Henry Draper Extension* (HDE, Cannon and Walton Mayall 1949) stars from *Harvard Annals*, Volume 112 and DM numbers (Bonnet 1978) was used to insert HDE numbers from the final HD volume.

Since the GC numbers in the cross index had been assigned by comparing HD numbers in the GC, stars without HD numbers in the cross index had missing GC numbers. The magnetic tape file of the GC was therefore searched by DM number for all stars having no GC numbers in the Cross Index. Additional GC numbers were found manually (by position) for GC stars not originally identified in the Cross Index and for the few remaining stars without DM numbers. Fourteen GC stars were found not to be in the SAO Catalog. HD numbers in the GC were then compared with their counterparts in the Cross Index for stars in common, leading to the detection and correction of a number of additional errors.

The Cross Index contains a numerical code appended to each HD number. The code originally followed the convention of the *Strasbourg Catalog of Stellar Identifications* (CSI, Ochsenein et al. 1981) which assigned the numbers 1, 2, ... for individual components of multiple systems and the digit 9 if two contiguous HD stars are included in the entry (the lower HD number is given with code 9). Since the component codes were assigned to CSI entries without regard to letter designations, and because letter designations have now been added, the HD code was changed to a consistent indication of major contamination of the spectral type of the particular component to which the entry applies by the spectrum of another star (see Table 2). A visual magnitude difference of 0.3 was used as the limit for which contamination was indicated. Although photographic magnitudes would have been more appropriate, the visual magnitudes in the SAO appeared to be more consistent.

A total of 8600 cross index records has been corrected or augmented with component and supplemental BD designations.

SECTION 2 - TAPE CONTENTS

A byte-by-byte description of the contents of the machine-readable *SAO-HD-GC-DM Cross Index* is given in Table 1. The suggested format specifications apply to FORTRAN formatted read statements and can be modified depending upon individual programming and processing requirements. All data fields with primary A-format specifications are blank for missing data; hence the alternate numerical specifications used for machine searches will produce zero values. Alternate format specifications are given in parentheses.

Table 1. Tape Contents. *SAO-HD-GC-DM Cross Index*.

Byte(s)	Suggested Format	Description
1- 6	I6	Number in the SAO Catalog. This number is the key to the records, i..e. the file is ordered by SAO number.
7	1X	Blank
8-13	A6 (I6)	Number in the HD catalog or its extensions (HDE).
14	1X	Blank
15	A1 (I1)	HD code (see Table 2 for descriptions of the codes).
16	1X	Blank
17-21	A5 (I5)	Number in the GC catalog.
22-23	A2	Identification of the DM catalog for which the following number is given (BD <i>Bonner Durchmusterung</i> or its southern extension; CD <i>Cordoba Durchmusterung</i> ; CP <i>Cape Photographic Durchmusterung</i>).
24	A1	Sign of DM zone.
25-26	A2 (I2)	DM zone.
27-31	A5 (I5)	DM number.
32-33	A2	Component identification(s) for double or multiple systems (A,B,AB,...) assigned according to precepts outlined in Section 1.
34	A1	Lower case letter (a,b,...) to designate that the given BD number is a supplemental (footnoted) entry.

Table 2 gives a description of each HD code that can occur in byte 15 of a data record.

Table 2. Explanation of HD Codes.

Code(s)	Meaning
0	Single star, or companion $>0^m3$ (visual) fainter than the primary to which the entry refers.
1	Brighter component with a companion $<0^m3$ fainter.
2	Fainter component with a companion $<0^m3$ brighter.
9	The SAO Catalog entry refers to two consecutive HD numbers, the lower of which is given.

SECTION 3 - TAPE CHARACTERISTICS

The information in Table 3 is sufficient for a user to describe the indigenous characteristics of the *SAO-HD-GC-DM Cross Index* to a computer. Information easily varied from installation to installation, such as block size (physical record length), blocking factor (number of logical records per physical record), total number of blocks, tape density, number of tracks, and internal coding (EBCDIC, ASCII, etc.) is not included. These parameters should always be transmitted if secondary copies of the catalog are supplied to other users or installations.

Table 3. Tape Characteristics. *SAO-HD-GC-DM Cross Index*.

NUMBER OF FILES	1
LOGICAL RECORD LENGTH (BYTES)	34
RECORD FORMAT	FB*
TOTAL NUMBER OF LOGICAL RECORDS	258997

* Fixed block length (last block may be short)

SECTION 4 - REMARKS, ACKNOWLEDGMENTS AND REFERENCES

The individual data corrections, additions and changes included in this version of the *SAO-HD-GC-DM Cross Index* number 11,398, with 8600 (3.3%) records having at least one change. Since many of the changes involve corrections to data given in previously published catalogs, it is important for a user to be able to refer to the individual changes if a discrepancy is found between this catalog and a previously published one. For this reason, we have prepared a complete table of all changes made to the original version (Morin 1973). The table was prepared by comparing the original *Table of Correspondences* with the complete revised Cross Index by computer. The resulting table is given on the microfiche cards contained in the envelope inside the back cover of this document. If a data entry is blank in either version, it is blank for the corresponding item in the table. The column labeled "S" gives the source of the change, as defined by its numerical code in Table 4.

Table 4. Sources for Changes in the *SAO-HD-GC-DM Cross Index*.

Code	Source(s)
1	Haramundanis, K., <i>Errata Sheet for the SAO Star Catalog</i> (undated) <i>Note on SAO Catalog Errata</i> (January 1971).
2	Stein, W. L. and Rudisill, J. C. 1977, <i>Introduction to the Dahlgren General Catalog</i> , Naval Surface Weapons Center NSWC/DL TR-3607. Stein, W. L. 1978, in Bischoff, M., <i>Bull. Inf. Cent. Données Stellaires</i> , No. 14, 2; No. 15, 103. Stein, W. L., private communications.
3	Bischoff M. 1978, <i>Bull. Inf. Cent. Données Stellaires</i> , No. 14, 2; No. 15, 103.
4	Hoffleit, D., private communication.
5	Parsons, S. B. 1977, <i>Bull. Inf. Cent. Données Stellaires</i> , No. 12, 41.
6	Nagy, T. A. 1979, <i>Documentation for the Machine-Readable Version of the Smithsonian Astrophysical Observatory Catalog</i> [ue] (EBCDIC Version), Systems and Applied Sciences Corporation R-SAW-7/79-34.
7	Houziaux, L. and Blondelot-Lickes, J. 1970, Centre Univ. Mons, Fac. Sci., <i>Dép. Astrophys.</i> , Communication No. 13.

Table 4. (continued)

Code	Source(s)
8	Stoy, R. H. 1968, <i>Cape Photographic Catalogue for 1950.0, Zones -80° to -90°, Ann. Cape Obs. 22</i> (London: Her Majesty's Stationery Office).
9	McLaughlin, S. F., private communication.
10	Bonnet, R. 1978, <i>Cross Identifications of HDE Stars, Bull. Inf. Cent. Données Stellaires, No. 15, 115</i> . Magnetic tape version, CDS Strasbourg catalog number 4008.
11	Warren, W. H. Jr. and Kress, K. 1980, <i>Catalog of Supplemental Stars to the Bonner Durchmusterung, Astron. Data Center Bull. 1, 19</i> .
12	Errors and Additions from the present work.
13	Schmidtke, P.C., private communication.
14	Herald, D. 1979, <i>Occultation Newsl. 2, 49</i> .

Table 5 includes further notes on entries in the microfiche table for which additional explanations are considered useful to clarify the reasons for certain changes.

Table 5. Explanatory Notes to Individual Changes

SAO	Note(s)
6404	The GC incorrectly identifies this star as BD+76° 309; GC 11190 is BD+76° 309, while this star is +77° 309.
9949	This star is misidentified as BD+70° 1162 in the GC, as it is in the IDS and ADS (Aitken 1932). Source 3 corrects the DM number to +70° 1161, assuming that the double entry for +70° 1161 represents the two components of the double star. This is not the case. SAO 9949 is a duplicate entry and should be deleted.
15097	The GC incorrectly lists this star as BD+65° 761. It is actually +65° 751, while +65° 761 is SAO 15120, which does not appear in the GC.

Table 5. (continued)

SAO	Note(s)
17589	The GC incorrectly identifies this star as BD+68° 936; it is actually +69° 936.
23221	Source 1 incorrectly gives this star as BD+53° 508, while source 3 identifies it as BD+53° 568a. It is actually +52° 568a.
24753	This star is listed as BD+57° 825 in several catalogs. It is not in the proper position for the BD star, however. There is a star at the SAO position on photographs, but which is not in the BD.
29370 29372	These corrections are probably in error. The BD gives +54° 1724 as being SW of +54° 1725 and lists both stars as magnitude 7.5. The SAO, AGK3 and IDS list the brighter star ($\Delta m \sim 0.16$) as SE. The HD also lists the brighter star as south, but gives the same right ascension for both stars. The IDS identifies the brighter star as BD+54° 1724, as do the HD and the SAO, but the AGK3 reverses the DM numbers, listing the brighter star as +54° 1725.
101858	Sources 2 and 3 suggested changing this star to BD+17° 2945. It is part of a triple system, of which C, the fainter, more distant component, is +17° 2945. SAO 101858 and 101859 appear to be the A and B components, respectively, of +17° 2946.
238176	The GC is in error. GC 14513 is CP-54° 3795 and is not in the HD. GC 14517 is CP-54° 3797, which is HD 91593.

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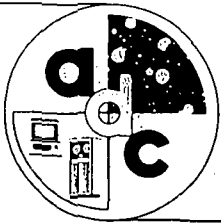
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SECTION 5 - SAMPLE LISTING

The sample listing given on the following pages contains logical data records exactly as they are recorded on the tape. Groups of records from the beginning and the end of the catalog are illustrated. The beginning of each record and bytes within the record are indicated by the column heading index across the top of each page (digits read vertically).



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