DATA SET CATALOG #48

Smithsonian Astrophysical Observatory

CORRSOA 2 tapes

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1. INTRODUCTION:

The documentation for this data set was originally on paper, kept in NSSDC's Data Set Catalogs (DSCs). The paper documentation in the Data Set Catalogs have been made into digital images, and then collected into a single PDF file for each Data Set Catalog. The inventory information in these DSCs is current as of July 1, 2004. This inventory information is now no longer maintained in the DSCs, but is now managed in the inventory part of the NSSDC information system. The information existing in the DSCs is now not needed for locating the data files, but we did not remove that inventory information.

The offline tape datasets have now been migrated from the original magnetic tape to Archival Information Packages (AIP’s).

A prior restoration may have been done on data sets, if a requestor of this data set has questions; they should send an inquiry to the request office to see if additional information exists.

2. ERRATA/CHANGE LOG:

NOTE: Changes are made in a text box, and will show up that way when displayed on screen with a PDF reader.

When printing, special settings may be required to make the text box appear on the printed output.

Version	Date	Person	Page	Description of Change
01				
02				

3 LINKS TO RELEVANT INFORMATION IN THE ONLINE NSSDC INFORMATION SYSTEM:

http://nssdc.gsfc.nasa.gov/nmc/

[NOTE: This link will take you to the main page of the NSSDC Master Catalog. There you will be able to perform searches to find additional information]

4. CATALOG MATERIALS:

a. Associated Documents — To find associated documents you will need to know the document ID number and then click here. http://nssdcftp.gsfc.nasa.gov/miscellaneous/documents/

b. Core Catalog Materials

```
C   FORTRAN DRIVER
C
      DIMENSION ROUT(1),IOUT(30)
      COMMON /PIFTC1/IPCC/PIFTC2/IN(1)/PIFTC3/JUNK,JOUT(1)
      EQUIVALENCE (ROUT(1),IOUT(1))
      IJ=0
    1 CALL PIFTAO (1HA)                                        .1
      IF(IPCC .EQ. 1) GO TO 1                                  .2
      IF(IPCC .EQ.0) GO TO 100                                 .3     .4
      GO TO 3                                                  .6     .7
  100 IJ=IJ+1                                                  .9
      IFLAG=0                                                  .10
      IF(IJ .LT. 3) GO TO 2                                    .11
      IF(IJ .EQ. 1308) GO TO 2                                 .12    .13
      IF(IJ .GT. 2613) GO TO 2                                 .15    .16
      GO TO 1                                                  .18    .19
    2 DO 10 I=1,1500,30                                        .21
      K=I+29                                                   .22
      L=1                                                      .23
      DO 11 J=I,K                                              .24
      IOUT(L)=JOUT(J)                                          .25
   11 L=L+1                                                    .26
      ROUT(1)=(FLOAT(IOUT(1)))/2.0**26                         .27    .28
      ROUT(2)=IOUT(2)                                          .29
      ROUT(3)=(FLOAT(IOUT(3)))/2.0**26                         .30
      ROUT(4)=IOUT(4)                                          .31
      ROUT(5)=(FLOAT(IOUT(5)))/2.0**31                         .32
      ROUT(6)=(FLOAT(IOUT(6)))/2.0**30                         .33
      ROUT(7)=IOUT(7)                                          .34
      ROUT(8)=(FLOAT(IOUT(8)))/2.0**31                         .35
      ROUT(9)=(FLOAT(IOUT(9)))/2.0**30                         .36
      ROUT(10)=IOUT(10)                                        .37
      ROUT(11)=(FLOAT(IOUT(11)))/2.0**7                        .38
      ROUT(12)=(FLOAT(IOUT(12)))/2.0**5                        .39
      ROUT(12)=ROUT(12)+1E50.                                  .40
      ROUT(13)=(FLOAT(IOUT(13)))/2.0**26                       .41
      ROUT(14)=(FLOAT(IOUT(14)))/2.0**7                        .42
      ROUT(15)=(FLOAT(IOUT(15)))/2.0**5                        .43
      ROUT(15)=ROUT(15)+1E50.                                  .44
      ROUT(16)=(FLOAT(IOUT(16)))/2.0**26                       .45
      ROUT(17)=IOUT(17)                                        .46
      ROUT(18)=IOUT(18)                                        .47
      ROUT(19)=IOUT(19)                                        .48
      ROUT(20)=IOUT(20)                                        .49
      ROUT(21)=IOUT(21)                                        .50
      ROUT(23)=IOUT(23)                                        .51
      ROUT(24)=IOUT(24)                                        .52
      ROUT(25)=IOUT(25)                                        .53
      ROUT(26)=(FLOAT(IOUT(26)))/2.0**26                       .54
      ROUT(27)=(FLOAT(IOUT(27)))/2.0**26                       .55
      ROUT(28)=(FLOAT(IOUT(28)))/2.0**26                       .56
      ROUT(29)=IOUT(29)                                        .57
      ROUT(30)=IOUT(30)                                        .58
      IF(IJ .EQ. 1) GO TO 4                                    .59
      IF(IJ .EQ. 1308) GO TO 5                                 .60    .61
                                                               .63    .64
```

T(1)

.1		
.2		
.3	.4	.5
.6	.7	.8
.9		
.10		
.11		
.12	.13	.14
.15	.16	.17
.18	.19	.20
.21		
.22		
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.27	.28	
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.48		
.49		
.50		
.51		
.52		
.53		
.54		
.55		
.56		
.57		
.58		
.59		
.60	.61	.62
.63	.64	.65

```
      DRIVER
 EXTERNAL FORMULA NUMFER   -   SOURCE STATEMENT   -   02/14/66
                                                      INTERNAL FORMULA NUMBER(S)
      IF(IJ .EQ. 2614) GO TO 6
      GC TC 13                                                .66    .67
    4 IF(IFLAG .EG. 1) GO TC 13                               .69
      IFLAG=1                                                 .70    .71
      WRITE(3,12)                                             .73
      GC TC 13                                                .74    .75
    5 IF(IFLAG .EG. 1) GO TC 13                               .76
      IFLAG=1                                                 .77    .78
      WRITE(3,14)                                             .80
      GC TC 13                                                .81    .82
    6 IF(IFLAG .EG. 1) GO TC 13                               .83
      IFLAG=1                                                 .84    .85
      WRITE(3,15)                                             .87
   13 WRITE(3,19)                                             .88    .89
      WRITE(3,9) (ROUT(IK), IK=1,6)                           .90    .91
      WRITE(3,20)                                             .92    .93
      WRITE(3,9) (ROUT(IK), IK=7,12)                          .97    .98
      WRITE(3,21)                                             .99    .100
      WRITE(3,9) (ROUT(IK), IK=13,18)                         .104   .105
      WRITE(3,22)                                             .106   .107
      WRITE(3,17) (ROUT(IK),IK=19,24)                         .111   .112
      WRITE(3,23)                                             .113   .114
      WRITE(3,9) (ROUT(IK), IK=25,30)                         .118   .119
   10 CONTINUE                                                .120   .121
      IF(IJ .GE. 2615) GO TC 3                                .125   .126
      GC TC 1                                                 .127   .128
    3 CALL SCLOSE                                             .130
      STOP                                                    .131
   12 FCRMAT(1H1,15HRECORDS 1 AND 2)                          .132
   14 FORMAT(1H1,11HRECORD 1306)
   15 FCRMAT(1H1,21HRECORDS 2614 AND 2615)
   19 FORMAT(/////120H          DECLINATION            VIS MAG          RT
     1ASCENSION          STAR          PROP MOT INCL          STAN DE
     2V    )
   20 FORMAT(/120H          PHOTO MAG          PROP MOT RT AS          STAN
     3DEV          PROP MOT          PHOTO MAG          DECL IN OBS
     4)
   21 FCRMAT(/120H          STAN DEV          VIS MAG          RT ASC
     5 OBS          STAN DEV          DM ZONE          DM NO
     6)
   22 FCRMAT(/120H          SMITH BK NO          SPECTRAL TYPE          DBL + VA
     7R STAR          SPECTRAL TYPE          ACC VIS MAG          ACC PHOTO MAG
     8)
   23 FORMAT(/120H          CAT STAR NO          DECLIN OBS          STAN
     9DEV          RT ASC OBS          UNUSED          CHECKSUM
     A)
    9 FORMAT(6E20.7)
   17 FCRMAT(3E20.7,17X,A3,2E20.7)
      END                                                     .133
```

.66	.67	.68		
.69				
.70	.71	.72		
.73				
.74	.75			
.76				
.77	.78	.79		
.80				
.81	.82			
.83				
.84	.85	.86		
.87				
.88	.89			
.90	.91			
.92	.93	.94	.95	.96
.97	.98			
.99	.100	.101	.102	.103
.104	.105			
.106	.107	.108	.109	.110
.111	.112			
.113	.114	.115	.116	.117
.118	.119			
.120	.121	.122	.123	.124
.125	.126			
.127	.128	.129		
.130				
.131				
.132				

VIS MAG RT
INCL STAN DE

T RT AS STAN
DECL IN OBS

MAG RT ASC
DM NO

L TYPE DBL + VA
ACC PHOTO MAG

OBS STAN
CHECKSUM

.133

D-02199
D-02200

SAO STAR CATALOG BINARY TAPES

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June 1967

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SAO STAR CATALOG BINARY TAPES

K. L. Haramundanis

1. INTRODUCTION

The Smithsonian Astrophysical Observatory has compiled a Star Catalog containing positions and proper motions for 258,997 stars. The equator and equinox of the Catalog are 1950.0; the positions are given (1) at epoch of observation and (2) with proper motions applied to epoch 1950.0.

The data recorded for each star on the binary tape are listed in the format (Section 2). An elementary description of data storage on magnetic tapes is given in Section 9, for those unfamiliar with this type of machine-accessible storage. Codes (Section 3) and book numbers (Section 4) indicate precise sources for the recorded data. The stars have been sorted by increasing right ascension within 10° bands of declination at epoch 1950.0. For the order of the files on the tapes and the number of records in each file, see Section 5.

For general use, the Catalog is stored on magnetic tapes compatible with IBM 729 II tape units at 556 bpi (bytes per inch), and nearly fills two 2400-foot 7-track reels. Since these tapes were originally written by the IBM 7094, which uses 36-bit words, the tape format was designed for this computer. Thus the information for one star is stored in 11 consecutive 36-bit words (396 consecutive bits). One tape record consists of data for exactly 50 stars (19,800 consecutive binary bits). Short records are padded with words of binary one's to bring them to full length, and occasionally a star has been deleted from the tapes by inserting in its place an 11-word set of binary one's.

Spectral type, an alpha-numeric field in word 8, has been recorded in the internal BCD code of the IBM 7094. To facilitate its interpretation on other computers, this code is given in Section 6. As an aid to the use of the tapes, a general Fortran interpreter is described in Section 7, and samples of interpreted data from file 1, record 1 of each tape are given in Section 8. Formulation of the Catalog is described in Section 10.

All inquiries concerning these tapes should be directed to: Star Catalog, Smithsonian Astrophysical Observatory, 60 Garden Street, Cambridge, Massachusetts, 02138, USA (telephone 617-864-7910).

2. ELEVEN-WORD BINARY TAPE FORMAT

Equator and equinox are 1950.0; epoch is (words 1, 2) 1950.0, or (words 9, 10) epoch of observation.

Each tape record contains 50 stars (550 words); short records are padded with words of binary one's to bring them to full length.

The contents of each word, by bits, are as follows:

Word 1:	S, 1-30(B4)	δ_{1950}, in radians
	31-35(B35)	code 10* (visual magnitude)
Word 2:	S, 1-30(B4)	α_{1950}, in radians
	31-35(B35)	code 20* (star numbers and footnotes)
Word 3:	S, 1-17[B(-14)]†	annual μ', in radians
	18-31(B1)	annual $\sigma_{\mu'}$, in radians
	32-35(B35)	code 30* (photographic magnitude)
Word 4:	S, 1-17[B(-14)]	annual μ, in radians
	18-31(B1)	annual σ_{μ}, in radians
	32-35(B35)	code 40* (proper motion)
Word 5:	S, 1-11(B4)	photographic magnitude
	12-23(B18)	epoch of δ_0, in years minus 1850.00
	24-35(B9)	σ_{δ_0}, in radians
Word 6:	S, 1-11(B4)	visual magnitude
	12-23(B18)	epoch of α_0, in years minus 1850.00
	24-35(B9)	σ_{α_0}, in radians
Word 7:	S, 1-7(B7)	DM zone
	8-22(B22)	DM number
	23-29(B29)	Smithsonian book number (see Section 4)
	30-32(B32)	code 51* (spectral type)
	33-35(B35)	code 52* (double and variable stars)

Word 8:	S, 1-17	spectral type (BCD, see Section 6)
	18(B18)	code 60* (accuracy of visual magnitude)
	19(B19)	code 70* (accuracy of photographic magnitude)
	20-35(B35)	source catalog star number
Word 9:	S, 1-22[B(-4)]	δ_0, in radians, low-order 22 bits only (use high-order 8 bits from word 1, sign bit from word 9)
	23-35(B9)	σ_{1950}, in radians (one value given that pertains to either α or δ)
Word 10:	S, 1-30(B4)	α_0, in radians
	31-35	not used
Word 11:	checksum of words 1-10	

Note: Spectral types have no signs; they begin with a letter and are followed by a single-digit number, occasionally by a letter and a number. The exception is +++ (see Section 3, code 51).

The notation follows, in order of appearance:

S = sign bit

B = placement of binary point, i. e., the bit after which the separation between integral and fractional part of the binary number is implied (fixed-point format)

α = right ascension

δ = declination

σ = standard deviation

μ = annual proper motion in right ascension

μ' = annual proper motion in declination

DM = Durchmusterungen, identification catalogs of the last century

subscript xx_0 = at epoch of observation

subscript xx_{1950} = at epoch 1950.0

* = See Section 3, codes.

3. CODES

3.1 Code 10: Visual Magnitude

Code Visual	Code Photo-visual	Magnitude source
0		Does not appear in source catalog
1	21	Determined by source catalog
2		Determined by source catalog or by authority in footnote
3	23	Source cited in source catalog introduction
	24	Source unspecified
5		Taken from BD
8		Based on Durchmusterung magnitudes and visual estimates
9		Taken from AGK 1
10		Taken from Cordoba Zones (Resultados)
12		Taken from CGA or Cordoba Zones
13		Taken from Harvard Publications
14		Taken from Harvard or San Luis Photometry
15		Taken from Henry Draper
16		Combined magnitude of component stars
17		Arithmetic mean of maximum and minimum magnitudes of a variable star

Where no figures were reported for magnitudes of a variable star, 0.00 was stored on the tapes (i.e., always check code 52 when using magnitudes). When blank, code = 0, and field = zeros.

3.2 Code 20: Star Number and Footnotes

Footnote without	Footnote with	Star number
0	16	Source catalog only
1	17	Source catalog and BD
2	18	Source catalog and CD
3	19	Source catalog and CPD
4	20	Cordoba B (Resultados) and CD
5	21	Cordoba A (Resultados) and CD
6	22	AGK1 and BD
7		GC and BD
8	24	Cordoba B (Resultados) and CPD
9		Cordoba A (Resultados) and CPD

When blank, code for DM is 0 or 16, footnote is 0 through 9, and field is zeros. Footnotes and star numbers are those appearing in the source catalogs.

3.3 Code 30: Photographic Magnitude

Code	Source
0	Does not appear in source catalog
1	Determined by source catalog
4	Taken from magnitudes of the CPD and diameters of the Cape Astrographic Catalog
8	Source cited in source catalog introduction
9	Columbia Contributions Nos. 30 and 31 (Schilt)

When blank, code is 0, field is zeros.

3.4 Code 40: Proper Motion

Code	Source
1	Determined in source catalog
3	Determined by comparison of catalog and Greenwich AC
5	Determined by comparison of catalog and AGK 1
6	Determined by comparison of catalog and Greenwich AC on the basis of the smallest difference in positions (see Section 10.3)
8	Determined by comparison of catalog with AGK 1 on the basis of the smallest difference in positions (see Section 10.3)

when blank, code is 0, field is zeros.

3.5 Code 51: Spectral Type

Code	Source
0	Taken from the Henry Draper or no spectrum in source catalog
1	Taken from the HD with M stars reclassified by Miss Cannon
2	Classified by G. G. Cillie
3	Classified by Goedicke
4	Classified by D. Hoffleit
5	Classified by M. V. Mayall
6	Classified by McCormick Observatory
7	Classified by Nassau and Seyfert

Where no spectra were recorded, the code is 0 and the field is BCD blanks. If the spectrum is composite, +++ is stored in the field, and the code is 0.

3.6 Code 52: Miscellaneous

Code	Meaning
0	No additional information
1	Double star, see source catalog for source
2	Double star in Aitken's Double Star Catalog
3	Double star in Burnham's Double Star Catalog
4	Variable star in visual magnitude in source catalog
5	Variable star in photographic magnitude in source catalog
6	Variable star in both magnitudes
7	Both double and variable, in either visual or photographic magnitudes

When blank, code is 0, no field involved.

3.7 Code 60: Accuracy of Visual Magnitude

Listed on tape as 0 or 1; 0 indicates the magnitude was reported in source catalog to $0^{m}.00$; 1, to $0^{m}.0$.

3.8 Code 70: Accuracy of Photographic Magnitude

Listed on tape as 0 or 1; 0 indicates the magnitude was reported in source catalog to $0^{m}.00$; 1, to $0^{m}.0$.

4. BOOK NUMBERS FOR SOURCE CATALOGS

No.	Abbreviated Title
01	AGK 2, vol. 1
02	AGK 2, vol. 2
03	AGK 2, vol. 5
04	AGK 2, vol. 6
05	AGK 2, vol. 7
06	AGK 2, vol. 8
20	Yale Transactions, vol. 11
21	Yale Transactions, vol. 12 I
22	Yale Transactions, vol. 12 II
23	Yale Transactions, vol. 13 I
24	Yale Transactions, vol. 13 II
25	Yale Transactions, vol. 14
26	Yale Transactions, vol. 16
27	Yale Transactions, vol. 17
28	Yale Transactions, vol. 18
29	Yale Transactions, vol. 19
30	Yale Transactions, vol. 20
31	Yale Transactions, vol. 21
32	Yale Transactions, vol. 22 I
33	Yale Transactions, vol. 22 II
34	Yale Transactions, vol. 24
35	Yale Transactions, vol. 25
36	Yale Transactions, vol. 26 I
37	Yale Transactions, vol. 26 II
38	Yale Transactions, vol. 27
40	Cape Annals, vol. 17
41	Cape Annals, vol. 18
42	Cape Annals, vol. 19
43	Cape Annals, vol. 20
48	Cape Zone
60	Melbourne 3
61	Melbourne 4
70	General Catalogue
71	FK3
74	FK4

5. ORDER OF FILES ON TAPE, AND NUMBER OF STARS IN EACH FILE

File	Band of δ	No. of stars	No. of records		Padding
		(a)	(b)	(c)	(d)
1	+80°	4 015	81	(4 050)	35
2	70	6 921	139	(6 950)	29
3	60	10 086	202	(10 100)	14
4	50	14 984	300	(15 000)	16
5	40	17 587	352	(17 600)	13
6	30	20 115	403	(20 150)	35
7	20	17 964	360	(18 000)	36
8	10	17 308	347	(17 350)	42
9	+ 0	19 567	392	(19 600)	33
Total		128 547	2 576	(128 800)	253
1	- 0°	18 504	371	(18 550)	46
2	10	18 958	380	(19 000)	42
3	20	26 325	527	(26 350)	25
4	30	22 603	453	(22 650)	47
5	40	16 966	340	(17 000)	34
6	50	16 203	325	(16 250)	47
7	60	7 522	151	(7 550)	28
8	70	2 579	52	(2 600)	21
9	-80	790	16	(800)	10
Total		130 450 +128 547 258 997	2 615	(130 750)	300

[50b = c; c-d = a]

6. INTERNAL IBM BDC CODE

Character	In storage	On tape	Character	In storage	On tape
0	00 0000	00 1010	-	10 0000	10 0000
1	00 0001	00 0001	J	10 0001	10 0001
2	00 0010	00 0010	K	10 0010	10 0010
3	00 0011	00 0011	L	10 0011	10 0011
4	00 0100	00 0100	M	10 0100	10 0100
5	00 0101	00 0101	N	10 0101	10 0101
6	00 0110	00 0110	O	10 0110	10 0110
7	00 0111	00 0111	P	10 0111	10 0111
8	00 1000	00 1000	Q	10 1000	10 1000
9	00 1001	00 1001	R	10 1001	10 1001
#	00 1011	00 1011	$\overline{0}$	10 1010	10 1010
@	00 1100	00 1100	$	10 1011	10 1011
&	01 0000	11 0000	*	10 1100	10 1100
A	01 0001	11 0001	blank	11 0000	01 0000
B	01 0010	11 0010	/	11 0001	01 0001
C	01 0011	11 0011	S	11 0010	01 0010
D	01 0100	11 0100	T	11 0011	01 0011
E	01 0101	11 0101	U	11 0100	01 0100
F	01 0110	11 0110	V	11 0101	01 0101
G	01 0111	11 0111	W	11 0110	01 0110
H	01 1000	11 1000	X	11 0111	01 0111
I	01 1001	11 1001	Y	11 1000	01 1000
+0}	01 1010	11 1010	Z	11 1001	01 1001
.	01 1011	11 1011	‡	11 1010	01 1010
⌑	01 1100	11 1100	.	11 1011	01 1011
			%	11 1100	01 1100

7. GENERAL FORTRAN INTERPRETER

Binary information for one star is contained in 396 consecutive bits. These bits were originally written on the tape from 11 words of a computer having 36-bit words. One tape record consists of data for 50 stars, i.e., 19,800 consecutive binary bits. A tape record may be copied by a standard <u>binary read</u> operation into the central memory of a second computer. When this second computer has a word length different from 36, correct interpretation of the binary information is complicated by two facts. First, data for the Nth star in the record will not generally begin with the first bit of a memory word. Second, bits denoting signs will not generally occupy the sign-bit position of their respective words. The following method of interpreting tape records should go far toward minimizing confusion and incorrect manipulation of bit groups.

As a first step it is convenient to define three integers. Let λ be the number of bits per central memory word for the second computer used. Then let α be the smallest integer for which $\alpha\lambda \geq 396$, and let β be the smallest integer for which $\beta\lambda \geq 19,800$. In Fortran statements that appear below, it must be stressed that the symbols λ, α, and β represent not variables but integer constants corresponding to a particular computer.

The second step is to create a special-purpose subprogram, which we might call JEM. It will need to be written in a language closer to basic machine language than Fortran because it will need to make use of elementary shift operations built into the computer. JEM must have the following properties:

a. Parameters used by JEM are passed in a manner that is compatible with the calling sequence generated for function subprograms by the Fortran compiler at the installation. A typical call to JEM is the Fortran statement K = JEM (N, NAME, M).

2. The word at K receives N consecutive bits taken from storage. The bits are right adjusted in K with zero fill to the left.

3. The first bit is taken from the Mth bit position from the left in the word at location NAME. Additional bits are taken from the right of this position.

4. If $(M + N - 1) > \lambda$, then extra bits are taken from the left end of the next word in the array to which NAME belongs.

5. $N > \lambda$ is invalid. Error indication is optional.

After a tape record has been read into storage, the 396 bits for a desired star should be placed in a standard configuration with the first bit at the beginning of a word. The following Fortran subroutine will do the job:

```
    SUBROUTINE STARGET (LARGE, L, LITTLE)
    DIMENSION LARGE (β), LITTLE (α)
    J = 396 * (L - 1)
    K = J/λ
    M = 1 + J - K * λ
    DO 1 I = 1, α
    N = I + K
  1 LITTLE (I) = JEM (λ, LARGE (N), M)
    RETURN
    END
```

The main program then will contain statements such as:

```
DIMENSION JACK (β), JILL (α)
.
.
.
.
CALL STARGET (JACK, N, JILL)
```

Execution of this call places the binary information for the Nth star of the record in the array JILL. Any star parameter can now be easily extracted from JILL by using the function JEM and a reference table such as Table 1.

A brief description of the table follows. The four left-hand columns describe the interpretation of the bit sequence and are independent of the computer. The columns headed "word" and "bit" depend on λ, and are shown for three different word sizes. Word and bit columns can be written down for any other value of λ in a minute or two. Begin each column with a 1. Each successive bit number is found by adding the bit number above to its corresponding N. If the sum exceeds λ, then subtract λ and increase the word count. Use of the table can best be shown with examples.

Example 1. On a machine with 32 bit words, find the epoch of δ_0. Two Fortran statements are sufficient:

```
x = JEM (12, JILL (5), 29)
EPOCH = 1850. + x/32.
```

Example 2. In the λ = 24 case, find the visual magnitude. Here a sign bit is involved. One Fortran solution is:

```
     KING = JEM (1, JILL (8), 13)
     x = JEM (11, JILL (8), 14)
     VIS = X/128.
     IF (KING) 2, 2, 1
1    VIS = -VIS
2    - - - -
```

Example 3. In the λ = 60 case, find α_0. Again, two statements are enough:

```
x = JEM (31, JILL (6), 25)
ALF = x/67108864.
```

If the word length is shorter, it might be troublesome to preserve the full accuracy of a_0. Not all computers have real-number (floating-point) arithmetic that is accurate to 31 binary places. In such cases a_0 would have to be split up into two numbers and treated with double-precision instructions. If these instructions are not available, then their equivalents have to be worked out explicitly by the programmer.

The last parameter, checksum, was computed by the original 36-bit word machine. It is the add-and-carry logical sum of the previous words of star data (overflow bits are added back in at the low-order position). To compare this checksum to a similar sum computed on a machine of different word length is a fairly sophisticated problem. Probably no practical way exists to do this in Fortran. However, omitting this test for reading accuracy should not be a matter of serious concern provided that the tape-reading equipment performs parity testing against the check bits on the tape.

Table 1. Storage Format — 11-Word Binary Tapes*

Quantity	Sign Bit	Divisor	N	λ = 24 Word	λ = 24 Bit	λ = 32 Word	λ = 32 Bit	λ = 60 Word	λ = 60 Bit
δ_{1950}	√	2^{26}	31	1	1	1	1	1	1
Code 10			5	2	8	1	32	1	32
α_{1950}		2^{26}	31	2	13	2	5	1	37
Code 20			5	3	20	3	4	2	8
Annual μ'	√	2^{31}	18	4	1	3	9	2	13
Annual $\sigma\mu'$		2^{30}	14	4	19	3	27	2	31
Code 30			4	5	9	4	9	2	45
Annual μ	√	2^{31}	18	5	13	4	13	2	49
Annual $\sigma\mu$		2^{30}	14	6	7	4	31	3	7
Code 40			4	6	21	5	13	3	21
Photographic magnitude	√	2^{7}	12	7	1	5	17	3	25
Epoch of δ_0 minus 1850.0		2^{5}	12	7	13	5	29	3	37
$\sigma\delta_0$		2^{26}	12	8	1	6	9	3	49
Visual magnitude	√	2^{7}	12	8	13	6	21	4	1
Epoch of α_0 minus 1850.0		2^{5}	12	9	1	7	1	4	13
$\sigma\alpha_0$		2^{26}	12	9	13	7	13	4	25
DM zone	√		8	10	1	7	25	4	37
DM number			15	10	9	8	1	4	45
Smithsonian book number			7	10	24	8	16	4	60
Code 51			3	11	7	8	23	5	7
Code 52			3	11	10	8	26	5	10
Spectral type (in BCD)			18	11	13	8	29	5	13
Code 60			1	12	7	9	15	5	31
Code 70			1	12	8	9	16	5	32
Source catalog star number			16	12	9	9	17	5	33
δ_0 (low order 22 bits)	√	2^{26}	23	13	1	10	1	5	49
σ_{1950}		2^{26}	13	13	24	10	24	6	12
α_0		2^{26}	31	14	13	11	5	6	25
(Not used)			5	15	20	12	4	6	56
Checksum			36	16	1	12	9	7	1

*Notation for this table is described on page 4.

Table 2. File 1, record 1, north tape

Magnitudes		EPOCH 1950									ORIGINAL EPOCH							SOURCE		
m_{pg}	m_v	h	α_{1950} m	s	μ s	σ_μ 0.001s	δ_{1950} ° ′ ″	μ' ″	$\sigma_{\mu'}$ 0.001	ϵ_{1950}	α_2 s	σ 0.01	ep.	δ_2 ″	σ' 0.01	ep.	Sp.	Cat.	Star Number	[illegible] Number
	7.27	0	0	1.057	-0.0023	04	82 41 41.82	0.002	04	0.25	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	GC	[illegible]	[illegible]
	7.77		0	7.607	0.0214	06	89 8 11.79	0.025	04	0.31	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	GC	[illegible]	[illegible]
9.6	9.20		0	15.843	0.0051 Q	09	87 22 42.87	0.000	09	0.24	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	AG	[illegible]	[illegible]
10.2	5.10		0	40.172	0.0253 A	10	93 12 44.55	-0.025	20	0.16	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	AG	[illegible]	[illegible]
10.7	9.10		0	51.747	0.0031 Q	09	80 23 13.73	0.019	09	0.25	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	AG	[illegible]	[illegible]
	9.3A		1	0.697	-0.0090	06	86 5 39.49	-0.002	06	0.11	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
11.0	9.2B		1	22.974	0.0041 Q	10	84 50 15.41	0.007	10	0.27	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
11.1	9.4B		1	38.510	0.0056 Q	10	84 31 41.54	-0.016	10	0.26	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
11.7	9.50		2	0.531	0.0039 Q	10	82 38 8.19	-0.009	10	0.28	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
10.7	9.40		2	1.365	0.0100 Q	10	83 22 41.42	0.003	10	0.26	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
10.9	9.50		2	33.422	-0.0128 Q	09	82 25 7.68	-0.504	09	0.25	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
11.2	9.50		2	56.515	0.0212 Q	10	82 4 31.52	0.038	18	0.26	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
9.4	8.80		3	2.749	-0.0031 Q	09	90 47 31.10	-0.043	09	0.24	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	8.6A		3	3.903	-0.0185	06	87 36 19.64	0.029	06	0.11	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	5A		3	35.773	0.0096	06	85 22 23.47	0.145	06	0.13	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

Table 3. File 1, record 1, south tape

Magnitudes		EPOCH 1950									ORIGINAL EPOCH							BONNER		
m_{pg}	m_v	α_{1950} h	m	s	μ s	ϵ_μ 0.0001	δ_{1950} ° ' "	μ' "	$\epsilon_{\mu'}$ 0.001	ϵ_{1950} "	α_1 s	ϵ 0.01	ep.	δ_1 "	ϵ' 0.01	ep.	SP	Cat.	Star Number	DM Number
	8.5A	0		1.297	-0.0017	09	-5 22 54.57*	-0.000	07*	0.22	1.375	16	33.7	54.49	16	33.7	F2	17	8192	A -9 6160
	9.6A		0	5.287	0.0017	12	-5 41 58.41	0.002	12	0.25	5.219	16	33.7	58.55	16	33.7	G0	16	8160R	A -9 6310
	8.7A		0	13.301	-0.0003	09	-3 11 41.40	-0.034	09	0.22	13.306	16	33.7	10.85	16	33.7	A5	17	8193	A -3 5752
	9.4A	0	0	17.972	0.0020	12	-6 32 11.66	-0.014	12	0.25	13.914	16	33.7	11.41	16	33.7	G5	16	8161	A -7 6137
	8.0A		0	23.253	0.0009	09	-1 10 19.03	-0.005	11	0.22	23.394	17	37.2	18.35	17	37.2	K0	21	5944	A -4 6520
	8.1A		0	29.365	0.0034	12	-8 5 38.56	-0.001	12	0.23	29.311	16	33.7	38.51	16	33.7	G5	16	8162	A -8 6232
	9.0A		0	37.130	-0.0012	11	-7 55 13.07	-0.013	11	0.23	37.129	16	33.7	12.85	16	33.7	G5	16	8165	A -8 6233
	9.0A		0	41.360	-0.0019	12	-5 44 17.05	0.065	12	0.25	43.351	16	33.7	12.12	16	33.7	F8	15	8164	A -6 6351
	9.6A		0	43.449	0.0118	06	-0 26 30.82	-0.068	11	0.22	44.519	17	37.2	29.14	17	37.2	F8	21	5965	A -0 6512
	8.8A		0	44.837	-0.0018	09	-4 25 26.53	-0.006	09	0.22	45.856	16	33.7	26.51	16	33.7	F2	17	8195	A -4 6015
	8.9A		1	8.099	0.0016	09	-1 50 2.67	0.001	09	0.22	7.982	16	33.7	1.69	16	33.7	B8	17	8200	A -2 6004
	9.0A		1	11.399	0.0010	09	-3 46 42.20	0.002	09	0.22	11.392	16	33.7	47.23	16	33.7	G2	17	8201	A -4 6014
	8.7A		1	25.443	0.0022	09	-4 35 16.67	-0.056	09	0.22	25.411	16	33.7	15.76	16	33.7	K0	17	8202	A -5 6103
	9.0A		1	37.296	0.0007	09	-5 12 16.66	-0.093	09	0.22	37.286	16	33.7	16.51	16	33.7	A2	17	8203	A -5 6125
	9.6A		1	41.080	0.0015	09	-0 17 8.91	0.010	11	0.22	41.065	17	37.2	9.05	17	37.2	K2	21	5917	A -0 4015
	8.8A		1	45.418	-0.0006	12	-9 31 41.45	0.010	12	0.25	45.429	16	33.7	41.61	16	33.7	K0	16	8165	A -10 6221
	8.4A		1	56.594	-0.0074	11	-7 16 36.50	-0.075	11	0.21	56.636	16	33.7	36.26	16	33.7	G0	16	8166	A -7 6112
	8.6A		2	6.209	-0.0004	12	-8 27 47.31	-0.017	12	0.25	8.213	16	33.7	47.83	16	33.7	K2	16	8167	A -3 6248
	8.8A		2	7.746	0.0007	09	-1 20 18.14	-0.014	11	0.22	7.738	17	37.2	18.96	17	37.2	F8	21	5738	A -1 6524
	8.4A		2	11.545	0.0006	09	-0 13 19.54	-0.017	11	0.22	11.997	17	37.2	19.37	17	37.2	F0	21	5985	A -0 6616
	9.0A		2	22.956	0.0000	12	-7 33 17.69	0.028	12	0.25	22.917	16	33.7	17.97	16	33.7	K0	16	8168	A +8 1241
	8.1T		2	29.925	0.0028	07	-0 45 50.55	-0.045	03	0.29	29.781	09	98.9	47.55	07	95.2	K8	GC	31	D* -6 4525
	8.7A		2	35.779	0.0012	07	-2 7 55.65	-0.021	09	0.22	35.760	16	33.7	55.09	16	33.7	K0	17	1	A -2 6310
	8.6A		2	44.587	0.0016	07	-2 4 21.83	0.015	09	0.22	44.550	16	33.7	22.00	16	33.7	G5	17	2	A -2 6072
	4.7H		2	46.510	-0.0004	01	-5 51 15.56	0.094	01	0.05	46.559	03	17.8	17.76	03	03.7	K0	F4	9082	-6 6197
	8.7A		2	51.232	-0.0026	09	-1 43 5.54	-0.036	09	0.22	51.275	16	33.7	4.95	16	33.5	F8	17	3	A -2 6093
	7.8A		2	51.899	-0.0006	09	-4 7 46.86	-0.038	09	0.22	51.918	16	33.7	46.24	16	33.7	K0	17	4	A -6 6019
	7.2T		2	54.519	-0.0009	17	-7 56 37.39	-0.065	11	0.73	56.527	21	01.7	33.23	19	99.6	K5	GC	65	-8 6242
	8.3A		2	56.610	0.0008	09	-2 5 54.51	-0.016	09	0.22	56.660	16	33.7	51.92	16	33.7	K0	17	5	A -8 6096
	7.6T		2	57.328	0.0061	07	-9 51 40.71	-0.058	07	0.47	57.402	17	36.6	37.32	13	97.8	F5	GC	69	-10 6227
	8.8A		3	2.315	-0.0011	13	-9 42 18.56	-0.022	17	0.30	2.382	18	33.2	18.59	16	33.9	F5 J	16	[illegible]	A -16 6229
	9.1A		3	6.101	-0.0024	12	-0 18 55.40	0.018	12	0.25	6.140	16	33.7	55.68	16	33.7	K0	16	3	A -8 6245
	8.7A		3	17.412	0.0014	12	-8 48 14.50	0.000	12	0.25	17.277	16	33.7	44.55	16	33.7	G5	16	4	A -9 6319
	8.2A		3	14.244	0.0011	09	-8 4 26.89	-0.011	11	0.22	14.250	17	37.2	24.56	17	37.2	G5	21	5953	A -0 6619
	9.8A		3	37.768	0.0011	09	-2 26 0.26	0.014	09	0.22	37.144	16	33.7	0.48	16	33.7	K0	17	6	A -2 6097
	8.5A		3	39.481	0.0000	09	-2 9 53.74	-0.051	09	0.22	39.480	16	33.7	52.87	16	33.9	F8	17	7	A -2 6098
	9.0A		3	45.985	-0.0015	11	-1 10 58.15	-0.054	13	0.25	45.805	16	33.9	57.32	16	33.7	K2	17	8	A -5 6099
	9.5A		3	56.545	0.0001	09	-4 7 39.35	-0.074	11	0.22	56.544	16	33.7	38.98	16	33.7	F0	17	9	A -4 6222
	9.1A		4	6.992	0.0017	09	-4 2 56.40	-0.001	09	0.26	6.764	16	33.7	56.72	16	33.7	G0	17	10	A -4 6024
	8.1A		4	13.134	0.0015	13	-4 17 37.99	-0.100	13	0.47	13.677	16	33.7	36.36	16	33.2	F8	17	11	A -0 6257
	9.2A		4	14.316	0.0006	12	-8 20 13.52	0.007	12	0.25	14.530	16	33.7	13.50	16	33.7	G0	16	5	A -5 6323
	8.8A		4	20.653	-0.0067	13	-2 54 5.81	-0.224	11	0.27	20.774	16	33.7	1.85	16	33.7	G0	17	12	A -1 6025
	8.8A		4	38.076	-0.0012	09	-2 59 35.61	-0.097	09	0.22	38.076	16	33.7	35.58	16	33.7	K0	17	13	A -3 5761
	9.5A		4	52.160	0.0022	09	-1 19 28.01	-0.010	09	0.22	52.126	16	33.7	37.61	16	33.7	G4 F	17	14	A -2 1
	9.0D		5	2.242	-0.0011	06	-4 45 27.50	-0.101	06	0.19	2.167	13	00.2	27.09	14	93.0	G0	GC	1110	D* -5 2
	9.1A		5	1.811	-0.0013	14	-0 4 56.76	-0.009	20	0.26	4.678	17	37.2	56.45	17	37.2	K5	21	5	A* -0 1
	[illegible]		5	6.675	0.0011	14	-4 11 56.78	-0.010	12	0.25	6.136	16	33.7	58.29	16	33.7	G5	16	2	A -8 2
	[illegible]		5	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0.11	13.261	08	07.6	37.16	05	07.5	K8	GC	114	B* -1 2
	[illegible]		5	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0.22	11.612	16	33.7	36.15	16	33.7	K0	17	17	A -2 3
	[illegible]		5	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0.25	14.136	16	33.7	51.22	16	33.7	K0	16	8	A -6 1

9. ELEMENTARY DESCRIPTION OF DATA STORAGE ON MAGNETIC TAPE

All computers have information storage devices that allow them to store data accessibly (core storage, magnetic drum, etc.). In this storage unit, information is stored in binary (BIN) or binary-coded-decimal (BCD). A programmer may restrict himself to the BCD mode, but for handling large amounts of data, this is generally inefficient.

A computer stores data in units called words, each computer having a set word length. The IBM 7094, for example, has a word length of 36 bits, the CDC 6400, one of 60 bits. Additionally, each computer has a known maximum capacity, i.e., the maximum number of words that can be accommodated at the same time in the storage unit. Since the SAO Star Catalog was processed on an IBM 7094, it was constructed according to the capacity and word length of this computer.

The binary format (Section 2) of the Catalog contains eleven 36-bit words per star, all the numerical information being stored in fixed-point. The first bit of each word is the sign bit; in this bit a 0 = +, a 1 = -. The remaining 35 bits contain the magnitude of the number. The point that separates the integral from the fractional part of the word is called the binary point, and is indicated for each word on the format (Section 2). Conversion from binary to decimal is, for example,

```
bits  000000000000000000000000000000000001  = +1
      s1                                  35

bits  100000000000000000000000000000000001  = -3
      s1                                  35
```

The less efficient BCD system allocates a 6-bit binary number for each character, as given in Section 6 (for the BCD spectral type).

It is possible to convert the entire Star Catalog into the BCD mode, as was done in order to produce the book form of the Catalog; but, because of the inefficiency of the BCD format, in this mode the Catalog occupies 14 tapes rather than 2.

Binary information can be stored on punched cards, but in quantity is more generally stored on magnetic tapes. Information in this form is recorded magnetically in seven parallel channels (tracks) along the tape. On the tape, six of the channels are used to accommodate data, while the seventh contains a check bit, which merely checks the reliability of the data stored. As data are recorded on the tape the check bits are automatically computed by the tape control circuits; as a tape is read the check bit is recomputed and compared with the one previously read, discrepancies being indicated.

The IBM 7094 records data in 36-bit words, each word being divided into 6-bit bytes for storage on tape. Each byte with its check bit is recorded on tape in a vertical column; a tape can be recorded at 200, 556, or 800 bpi (bytes per inch). The Star Catalog is recorded at 556 bpi.

Any block of words recorded consecutively on a tape is called a record, no matter what its length. Following a record on a tape is a 3/4-inch blank space called an end-of-record gap or record gap. The Star Catalog contains fifty 11-word stars, or 550 words per record. An entire record must be stored in the computer at one time to prevent loss of data while copying or processing a Star Catalog tape.

Records may be grouped into files, each of which is separated from other files by a 3.7-inch blank space followed by a tape mark (the end-of-file record). The Star Catalog has been divided into 10° bands of declination, each band being stored in a separate file on the tapes.

10. FORMULATION OF THE STAR CATALOG

The SAO Star Catalog was compiled from several earlier catalogs, all of which are cited in the bibliography. In the compilation, all stars were reduced to a common fundamental system, the FK4, with the application of systematic corrections as given in the bibliography (Section 2.2), and to a common equator and equinox, 1950.0. Where necessary, proper motions and spectral types were added to the data for the recorded stars. The compilation gives positions and proper motions for 258,997 stars, with an average distribution of 6 stars per square degree. The star positions have an average standard deviation of 0.2 arcsec at epoch of observation or 0.5 arcsec at epoch 1963.5.

The SAO catalog includes the following information for each star:

1. Right ascension (α_{1950}) and declination (δ_{1950}) for equator, equinox, and epoch 1950.0.
2. Standard deviation (σ) of the position at epoch 1950.0.
3. Right ascension (α_0) and declination (δ_0) for the equator and equinox 1950.0, at the mean epoch of the original observations.
4. Standard deviations (σ, σ') of α_0 and δ_0.
5. Mean epochs (t_0, t_0') of the original observations in right ascension and declination.
6. Annual proper motions for right ascension (μ) and declination (μ').
7. Standard deviations (σ) of μ and μ'.
8. Visual magnitude (for 99% of the stars).
9. Photographic magnitude (for 50% of the stars).
10. Spectral type (for 83% of the stars).
11. Durchmusterung number (BD, CD, CPD).
12. Source catalog.
13. Star number from source catalog.
14. Explanatory notes.

10.1 Precession

Stars from catalogs that were referred to an equinox other than that of 1950.0 were precessed to 1950.0 by use of Newcomb's constant and the rigorous formulas,

$$l_0 = \cos\alpha_0 \cos\delta_0 ,$$

$$m_0 = \sin\alpha_0 \cos\delta_0 ,$$

$$n_0 = \sin\delta_0 ,$$

where

α_0, δ_0 = right ascension and declination at equinox of the source catalog, epoch t_0 .

l_0, m_0, n_0 = direction cosines referred to equinox of t_0 .

Setting up the matrix, we have:

$$\begin{pmatrix} l \\ m \\ n \end{pmatrix} = \begin{pmatrix} \cos\kappa\cos\omega\cos\nu - \sin\kappa\sin\omega & -\sin\kappa\cos\omega\cos\nu - \cos\kappa\sin\omega & -\cos\omega\sin\nu \\ \cos\kappa\sin\omega\cos\nu + \sin\kappa\cos\omega & -\sin\kappa\sin\omega\cos\nu + \cos\kappa\cos\omega & -\sin\omega\sin\nu \\ \cos\kappa\sin\nu & -\sin\kappa\sin\nu & \cos\nu \end{pmatrix} \cdot \begin{pmatrix} l_0 \\ m_0 \\ n_0 \end{pmatrix}$$

where

l, m, n = direction cosines referred to the equinox of 1950.0,

κ, ω, ν = angles given by the expressions:

$$\kappa = (2304''.53 + 1.39''.73\tau + 0''.06\tau^2)T + (30''.23 - 0''.27\tau)T^2 + 18''.00\ T^3,$$

$$\omega = \kappa + (79''.27 + 0''.66\tau)T^2 + 0''.32\ T^3,$$

$$\nu = (2004''.85 - 85''.33\tau - 0''.37\tau^2)T + (-42''.67 - 0''.37\tau)T^2 - 41''.80\ T^3,$$

in which

$$\tau = \frac{t_0 - 1900.0}{1000.0} ,$$

$$T = \frac{1950.0 - t_0}{1000.0} ,$$

and t_0 = epoch of original equinox in tropical years.

The positions at equinox 1950 are given by the relations

$$\alpha = \arctan \frac{m}{l} ,$$

$$\delta = \arcsin n .$$

This method is inaccurate within 10 arcmin of the pole; however, no stars within this region were processed.

10.2 Standard Deviations

Standard deviations (standard errors) of position were taken as given in the source catalogs. Probable errors (r) were converted to standard deviations by the formula,

$$\sigma = \frac{3}{2} r .$$

Where no standard deviations were given, but weights according to the number of observations were available from the GC (for meridian catalogs), the standard deviations were derived by use of the relations

$$\sigma = \frac{0''.45}{\sqrt{w}} , \qquad \sigma' = \frac{0''.45}{\sqrt{w'}} ,$$

where w and w' are the weights for right ascension and declination, respectively, and 0".45 is the GC standard deviation of unit weight.

Standard deviations of position from AGK 2 were computed (Schorr, 1951; Kohlschütter, 1957; Heckmann, 1955) by the formula

$$\sigma = \sigma' = \left\{ \left[(m - 9^{m}.12)^2 \, ''.0061 + ''.145 \right]^2 + ''.0036 \right\}^{1/2} ,$$

where m = photographic magnitude.

While some source catalogs gave standard deviation of the components of proper motion for each star, others gave only one value applicable to all its proper motions. In either case, standard deviations are given for proper motions of each star in the SAO catalog.

Standard deviations for proper motions computed at SAO were computed from the standard deviations of the positions:

$$\sigma_{\mu} = \frac{\left(\sigma_2^2 + \sigma_1^2\right)^{1/2}}{t_2 - t_1} ,$$

$$\sigma_{\mu'} = \frac{\left(\sigma_2'^2 + \sigma_1'^2\right)^{1/2}}{t_2 - t_1} ,$$

where subscripts 1 and 2 refer to earlier and later epochs, respectively. Since the standard deviations in α and δ for each star were very close, if not identical, the positional uncertainty at 1950.0 is indicated by a single number, given by the formula,

$$\sigma_{1950} = \left\{ \frac{(\sigma)^2 + \left[\sigma_{\mu}(1950.0 - t_0)\right]^2 + (\sigma')^2 + \left[\sigma_{\mu'}(1950.0 - t_0')\right]^2}{2} \right\}^{1/2} .$$

An additional term in this formula, which would make it more precise, is omitted because it cannot generally be evaluated from data given in the source catalogs, since it depends upon exact knowledge of the method of computing proper motions and on the epoch of observation of all positions used in determining proper motions.

All standard deviations in the printed SAO catalog are expressed in seconds of great circle arc, and on the magnetic tapes, in radians.

10.3 Proper Motions

Proper motions for AGK 2 stars were computed by comparing the AGK 2 positions (in the FK 3 system) with early epoch positions from either the AGK 1 or the Greenwich AC (in the FK 3 system), after identity of stars from these three catalogs had been determined by a series of tests on positions, BD numbers, and magnitudes. The following formulas were used:

$$\mu = \frac{\alpha_2 - \alpha_1}{t_2 - t_1} ,$$

$$\mu' = \frac{\delta_2 - \delta_1}{t_2 - t_1} ,$$

where μ, μ' are the proper motions in right ascension and declination, and the subscripts 1 and 2 refer to earlier and later epochs, respectively.

If two stars at t_1 or t_2 had the same BD number, the star for which the sum

$$(\alpha_2 - \alpha_1)^2 + (\delta_2 - \delta_1)^2$$

had the lowest value was used. When such a choice has been made, the fact is indicated in the catalog notes. When more than three stars at either t_1 or t_2 fulfilled all requirements for identification, the stars were omitted. Proper motions were computed for approximately 56,000 stars in the AGK 2.

Proper motions in right ascension, given in the source catalogs in seconds of great circle arc, were multiplied by the term sec $\delta/15$ and converted to seconds of time. In the printed catalog, the proper motions are given for right ascension in seconds of time, and for declination in arcsec. On the magnetic tapes all proper motions are given in radians.

10.4 Positions at 1950.0

Right ascension and declination at epoch 1950.0 are given by the equations

$$\alpha_{1950} = \alpha_0 + \mu\,(1950.0 - t_0) \;,$$

$$\delta_{1950} = \delta_0 + \mu'\,(1950.0 - t_0') \;.$$

10.5 Numbering System and Order

For the tapes of general interest and for the printed version of the catalog, the stars at epoch 1950.0 were sorted by right ascension within 10° bands of declination and, in the printed catalog, numbered consecutively (see Section 5).

10.6 Supplementary Information

Magnitudes, spectral types, and star numbers from the source catalogs have been included in the SAO catalog with explanatory notes citing the specific origin of each. Source-catalog entries indicating double or variable stars have also been incorporated in the explanatory notes. About 36,000 spectral types from the HD were added to the zones covered by the AGK 2, and Durchmusterung numbers were added to stars in the GC and the FK 4.

10.7 Duplicate Entries

When a star was listed in more than one source catalog, the duplicates were removed from the SAO catalog, insofar as this was possible. Stars were considered as duplicates when all the following were true: their positions, at the common epoch of 1900.0, agreed within 10″.0 in both coordinates; they had identical DM numbers; their visual magnitudes did not differ by more than 3.0 mag; they came from different catalogs; they were not noted as members of a double system.

When duplication occurred, the entry retained was that appearing first in the following list of catalogs: FK 4; FK 3; GC; Cape volumes 20, 19, 18, 17; Yale volumes 27, 26 II, 26 I, 25, 24, 22 II, 22 I, 21, 20, 19, 18, 17, 16, 14, 13 II, 13 I, 12 II, 12 I, 11; AGK 2 volumes 8, 7, 6, 5, 2, 1; Cape Zone; Me 4; Me 3.

11. BIBLIOGRAPHICAL SOURCES

11.1 Chief Sources

The chief sources used for the SAO catalog are listed under the abbreviated titles by which they are referred to in the text:

AGK 1

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1910. Catalog der Astronomischen Gesellschaft, No. 2. Zone +70° bis +75°, Berlin Sternwarte.

Fearnley, C., and Geelmuyden, H.
1890. Catalog der Astronomischen Gesellschaft, No. 3. Zone +65° bis +70°, Christiania Sternwarte.

Krüger, A.
1890. Catalog der Astronomischen Gesellschaft, No. 4. Zone +55° bis +65°, Helsingfors und Gotha Sternwarten.

Deichmüller, F.
1894. Catalog der Astronomischen Gesellschaft, No. 6. Zone +40° bis +50°, Bonn Sternwarte.

Engstrom, F., and Psilander, A. A.
1902. Catalog der Astronomischen Gesellschaft, No. 7. Zone +35° bis +40°, Lund Sternwarte.

Wilterdink, J. H.
1902. Catalog der Astronomischen Gesellschaft, No. 8. Zone +30° bis +35°, Leiden Sternwarte.

AGK 2

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BD

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CAPE ZONE

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FK 3

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FK 4

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GC

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GREENWICH AC

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HD

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Me 3

Ellery, R. L. J., and Baracchi, P.
1917. Third Melbourne General Catalogue of 3,068 Stars for the Equinox 1890.

Me 4

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1949. Catalogue of the Positions and Proper Motions of 7,996 Stars, +1° to +5°. Trans. Astron. Obs. Yale Univ., vol. 20.

1950. Catalogue of the Positions and Proper Motions of 5,583 Stars, -2° to +1°. Trans. Astron. Obs. Yale Univ., vol. 21.

1950. Catalogue of the Positions and Proper Motions of 9,060 Stars, +5° to +9°. Trans. Astron. Obs. Yale Univ., vol. 22, Part I.

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11.3 Errata

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Wolf, M

1909. Berichtigung. Astron. Nachr., vol. 181, pp. 15-16.

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SMITHSONIAN INSTITUTION
ASTROPHYSICAL OBSERVATORY
60 GARDEN STREET CAMBRIDGE MASSACHUSETTS 02138
TELEPHONE 617 864-7910

20 March 1969

Joe Johns
National Space Sciences Data Center
Code 601
NASA
Goddard Space Flight Center
Greenbelt, Maryland 20771

Dear Mr. Johns:

For your information I enclose the documentation concerning the magnetic tape version of the SAO Star Catalog. Dr. Gaposchkin has promised me two tapes for your copy of the Catalog which will be sent on to you separately.

Sincerely yours,

K. Haramundanis

(Mrs.) K.L. Haramundanis

KLH/lbc

enclosure

w/documentation
#3160

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enclosure

MAR 24 RECD w/documentation
#3160

PROGRAM DOCUMENTATION

SAØPIF

Smithsonian Astrophysical Observatory

Programmer: Nancy A. Norman

Date: August 8, 1969

Prepared by:

Wolf Research and Development Corporation
Riverdale, Maryland

Prepared for:

National Space Science Data Center
Space Sciences Division
GSFC
NASA

Under Contract NAS 5-8060

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Space Sciences Division
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NASA

Under Contract NAS 5-8060

I. ABSTRACT

SAØPIF unpacks the Smithsonian Astrophysical Observatory data and converts it from integer to real, printing-out a listing of the data in decimal notation.

II. IDENTIFICATION

A. Source Language

FORTRAN IV

B. Required Peripheral Equipment

Two tape units

1. One tape unit (A5) for input
2. One tape unit (A3) for off-line printer and decimal listing.

C. Computer

IBM 7094/II

D. Operating System

IBSYS (February 14, 1966 - Goddard Space Flight Center tape system).

E. Subroutines Required

PIFTAØ - FLØAT - QCLØSE

CØMMØN /PIFTC1/IPCC/PIFTC2/IN(1)/PIFTC3/JUNK,JØUT(1)

F. Storage Requirements

43647_{10}

III. DESCRIPTION

PIFTAØ is used to read and close the SAØ binary tape. The data is converted from integer to real with the subroutine FLØAT. A listing is printed containing record indicators, field titles and the decimal data.

IV. PROGRAM SETUP

A. Input Requirements

Tape

Tape Unit (5)

(1) Parity - odd

(2) 556 BPI

(3) No label

(4) Format, See Figure 2

(5) Disposition - save

B. Output Description

Printer Output

C. Control Cards

Control Card Sequence is shown in Deck Setup, Figure 1.

D. Run Time Estimate

15 minutes

E. Run Request Card

SPONSOR NUMBER | PROGRAMMER ID | PROJECT NO. | CTGY | TYPE | PROGRAM NUMBER | PROGRAMMER PRESENT

7094 MODE ☐ 1 ☐ 2 ☒ 32K ☐ 65K ☐ DISK ☐ DCC ☐ CARD READER ☐ PUNCH ☐ PRINTER

TIME EST. ____ HR 15 MIN PRINT EST. ________ REELS

LOGICAL	A- 5	A-	A-	A-	A-	A-	
TAPE NUMBER	X-348						
DISPOSITION	L F R	L F R	L F R	L F R	L F R	L F R	L F R
LOGICAL	B-	B-	B-	B-	B-	B-	
TAPE NUMBER							
DISPOSITION	L F R	L F R	L F R	L F R	L F R	L F R	L F R

PRINT TAPES

LOGICAL	1, 2, PC	FILES	COPIES	FORM	LOOP
A3	PC	1	1	STD	

KEYS ☐☐☐☐☐☐☐☐☐☐☐☐ SENSE ☐☐

LOAD CARDS ☐ ONLINE ☐ OFFLINE ☐ LOAD TAPE

DUMP IF ☐ MAX TIME ☐ TROUBLE ☐ EXCESSIVE O/P

SEE REVERSE ☐ SCHEDULED HALT ____________

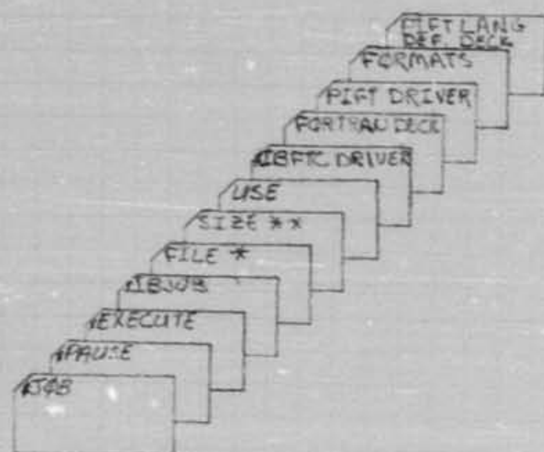
PUNCH TAPES

LOGICAL	FILES	CARD FORM

V. PROGRAM MAINTENANCE

Flow Chart, Figure 3.

FIGURE 1

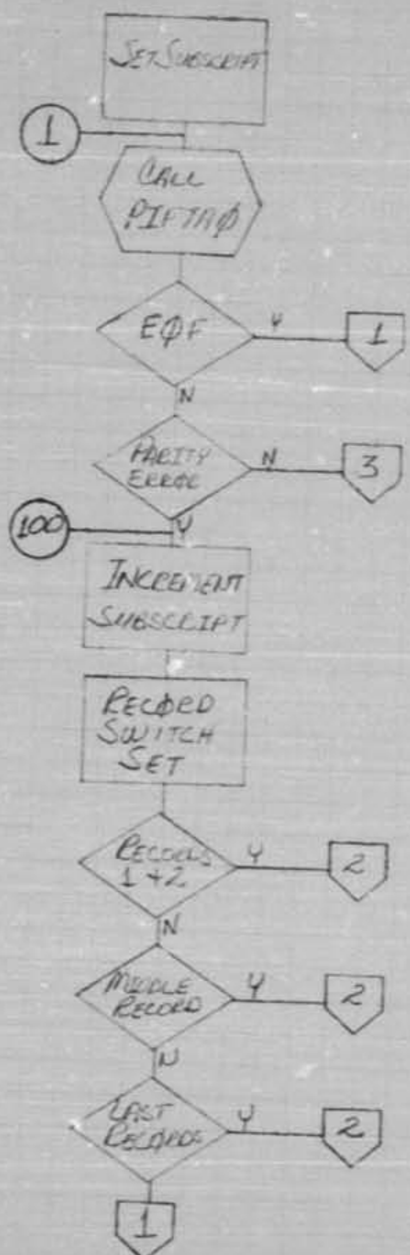


* FILE 'ARB, TAPE, INPUT', A(1), DEFER, BIN, 556, HOLD,
BLK=550, INPUT

** SIZE // = 8

Word	BITS	Description
1	S,1-30 (B4) 31-35 (B35)	declination in radians visual magnitude
2	S, 1-30 (B4) 31-35 (B35)	right ascension in radians star numbers and footnotes
3	S, 1-17 B(-14) 18-31 (B1) 32-35 (B35)	proper motion in declination in radians standard deviation in radians photographic magnitude
4	S, 1-17 B(-14) 18-31 32-35	proper motion in right ascension - radians standard deviation in radians proper motion
5	S, 1-11 (B4) 12-23 (B18) 24-35 (B9)	photographic magnitude declination observation standard deviation in radians
6	S, 1-11 (B4) 12-23 (B18) 24-35 (B9)	visual magnitude right ascension observation standard deviation in radians
7	S, 1-7 (B7) 8-22 (B22) 23-29 (B29) 30-32 (B32) 33-35 (B35)	DM zone DM number Smithsonian book number spectral type double and variable stars
8	S, 1-17 18 (B18) 19 (B19) 20-35 (B35)	spectral type accuracy of visual magnitude accuracy of photographic magnitude source catalog star number
9	S,1-22 B(-14) 23-35 (B9)	declination observation in radians standard deviation in radians
10	S, 1-20 (B4) 31-35	right ascension observation unused
11		Checksum

FIGURE 3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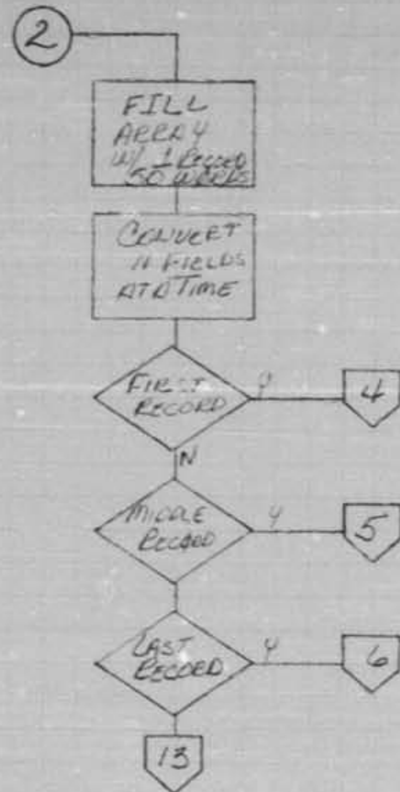
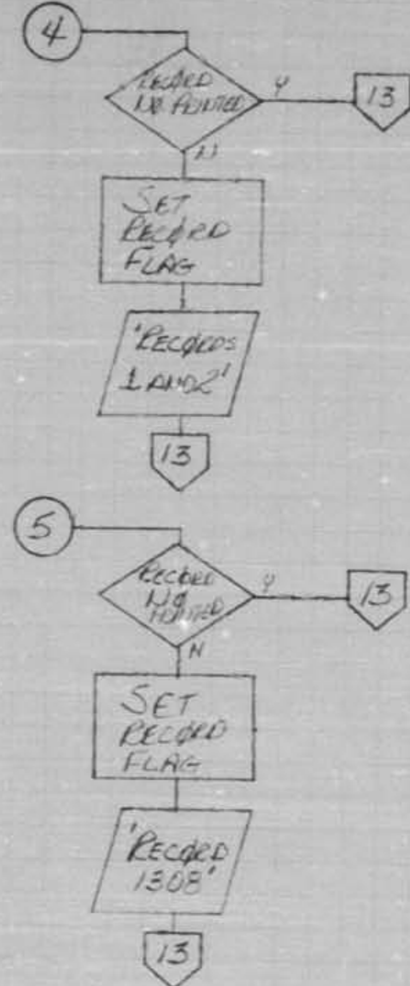
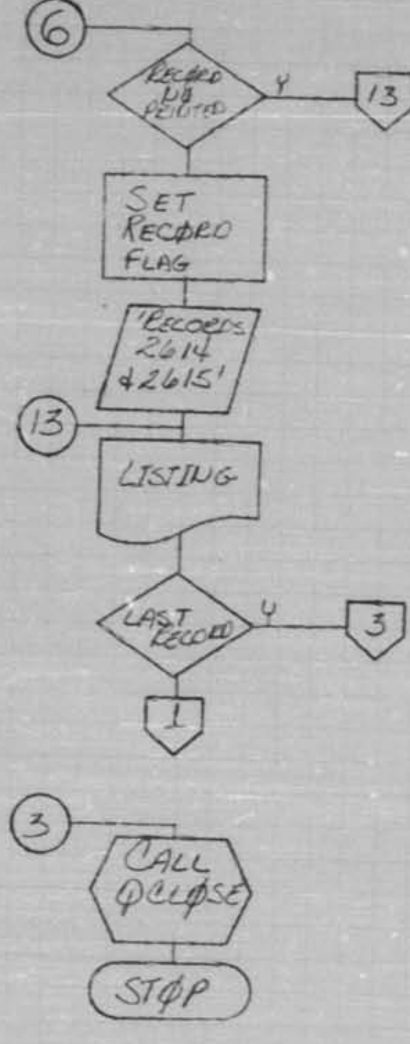
1
CALL PIFTMØ
EØF
Y
1
N
PARITY ERROR
N
3
100
Y
INCREMENT SUBSCRIPT
RECØRD SWITCH SET
RECORDS 1+2
Y
2
N
MIDDLE RECORD
Y
2
N
LAST RECORDS
Y
2
1


2
FILL ARRAY W/ 1 RECORD 50 WORDS
CONVERT 11 FIELDS AT A TIME
FIRST RECORD
Y
4
N
MIDDLE RECORD
Y
5
LAST RECORD
Y
6
13


4
Y
13
N
SET RECORD FLAG
'RECORDS 1 AND 2'
13
5
Y
13
N
SET RECORD FLAG
'RECORD 1308'
13


6
RECORD
NO
PRINTED
Y
13
SET
RECØRD
FLAG
'RECORDS
2614
&2615'
13
LISTING
LAST
RECORD
Y
3
1
3
CALL
ØCLØSE
STØP

72153	00000000 ROP00002336	00000000 ROPC0001023	00000000 ROPC0001262
72157	00000000 ROP00001745	00000000 ROPC0000604	00000000 ROPC0001465
72163	00000000 ROP00001522	00000000 ROPC0000365	00000000 ROPC0001573
72167	00000000 ROP00001513	00000000 ROPC0000335	00000000 ROPC0002542
72173	00000000 ROP00001365	00000000 ROPC0000360	00000000 ROPC0000753
72177	00000000 ROP00001702	00000000 ROPC0000472	00000000 ROPC0001506
72203	00000000 ROP00002661	00000000 00002240	00000000 ROPC0003364
72207	00000000 ROP00002772	00000000 ROPC0000667	00000000 ROPC0003244
72213	00000000 ROP00002133	00000000 ROPC0001516	00000000 ROPC0002075
72217	00000000 ROP00003750	00000000 00002003	00000000 ROPC0002546
72223	00000000 ROP00002722	00000000 ROPC0001407	00000000 ROPC0003374
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