

DEC-12-UW5A-D
June, 1970

NMR SIM(E)

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1.0 ABSTRACT

NMRSIM(E)¹ is designed to calculate theoretical spectra of compounds containing nuclei of spin one-half, including hydrogen, fluorine, and carbon-13. Chemical shifts for each nucleus and coupling constants between nuclei are input from the Teletype. Calculated line spectra are displayed on the VR12 scope. Twenty-five calibration points are displayed across the X axis. Output is to LINCtape and high- or low-speed paper tape punch, as well as to the Teletype. NMRSIM has options that allow varying all the parameters as well as offsets for enhancement of resolution. Chemical shifts and coupling constants may be adjusted continuously until the displayed theoretical spectrum is acceptable. Spectra may be read back and displayed from LINCtape or paper tape; several pspectra may be merged in this mode of operation, thereby allowing the simulation of large spin systems or mixtures of compounds.

2.0 EQUIPMENT

A PDP-12A equipped with KW12A real time clock and MC12 4K Memory Extension is required.

3.0 OPERATING PROCEDURES

NMRSIM(E) is loaded from a LAP6-DIAL² tape containing the program by the command

→ LO NMRSIM(E), Ø)

Refer to the LAP6-DIAL Programmer's Manual, DEC-12-SE2B-D for further details.

The restarting procedure is as follows:

- 1) Press the STOP key on the PDP-12A.
- 2) Press I/O PRESET.
- 3) Press START.

NMRSIM then returns to the display mode.

¹

NMRSIME utilizes the EAE option for the PDP-12.

²LAP6-DIAL is hereafter referred to as DIAL.

4.0 SPECTRUM GENERATION

After the program is loaded, it prints a series of messages on the Teletype to specialize the parameters for the experiment. The user types a reply to each message and terminates the response by pressing the RETURN key. If an illegal response is typed, a ? is printed on the Teletype and the message is repeated. The RUBOUT key can be used to erase incorrectly typed characters before a terminator is typed. The messages are listed below with their acceptable responses. Refer to section 8.0 for a sample dialogue.

4.1 COMMENTS:

Any amount of commentary can be typed at this time using any of the Teletype keys. After entering appropriate titles, type CTRL/A to advance to the next message.

4.2 WANT PAPER TAPE I/O?

Only a response of Y or N is acceptable. A reply of N stores the position and intensity of all calculated transitions on LINCtape only. A reply of Y outputs the position and intensity of all calculated transitions on paper tape in addition to LINCtape. After a reply of Y, a second question is printed:

WANT HIGH SPEED READER-PUNCH?

Type Y to use the high-speed punch, type N to output to the Teletype punch.

4.3 NO. OF SPINS =

Enter the number of spins; values from 1 through 6 are acceptable.

4.4 OFFSET & WIDTH

These two parameters define the range of the X axis on the scope. OFFSET is the value in Hz of the first point displayed along the horizontal axis. WIDTH is the total range in Hz of the horizontal axis. It is important to keep in mind that the axis will be displayed from right to left corresponding to the standard display mode for NMR data.

4.5 CHEMICAL SHIFTS:

Enter the value in Hz of the CHEMICAL SHIFTS in order. Type a comma to separate values:

1, 2, . . . , n

4.6 COUPLING CONSTANTS

Enter the value in Hz of the coupling constants in order:

$J_{1\ 2}, J_{1\ 3}, J_{1\ 4}, \dots, J_{1n}, J_{2\ 3}, J_{2\ 4}, \dots, J_{2n}, \dots, J_{(n-1)n}$

Specify every coupling constant required, even if the value is zero.

Type a comma after each value.

4.7 BLOCK, U:

Type the starting block in octal notation, a comma, and the number of the LINCtape transport unit to be used to store the peak parameters of the calculated transitions. The number of blocks required is dependent upon the size of the spin system desired.

The computer now calculates the theoretical spectra and automatically stores the data on the LINCtape.

5.0 COMMANDS

When displaying a line spectrum the Teletype is active and can be used to issue commands defining the next task for the computer. Six options are available to the user at this time. Each of these commands is issued by typing the appropriate letter followed by a colon. The command may be changed by using the RUBOUT key before the colon has been typed. The display can be scaled with Right Switches 9, 10 and 11.

5.1 R (RESTART)

Restart prints the message COMMENTS (section 4.1) and restarts the program. It is used to calculate a complete set of new data. Note that paper tape status can not be changed after the initial responses to the messages.

5.2 C (COUPLING CONSTANTS)

Returns to section 4.6 and requests new parameters. Used for open loop iteration to find the best coupling constants.

5.3 O (OFFSET & WIDTH)

This command allows a new section of the X axis to be displayed on the scope so that any section of the calculated spectrum can be displayed on the scope. The OFFSET option is useful for resolution enhancement. To exercise this option, there must be NMR data on LINCtape or paper tape (prepared by the P: command). If paper tape was requested during initialization (section 4.2), the question

TAPE INPUT?

is asked. Type Y to read data from the high speed or Teletype reader and write it on LINCtape before display. Type N to read data from LINCtape.

5.4 D (DIAL)

Program returns control to the DIAL Operating System.

5.5 L (LIST)

The L command lists intensity and energy data on the Teletype in tabular format. After typing L, the message

MIN. INTENSITY:

is printed. Type an integer number between 0 and 1000. If the intensity of the transition is greater than the entered value, the transition will be in the output list. This question thus serves as a threshold on the intensities that are listed. A second question

DISPLAY LIST

is then printed. Type Y to output only the lines which are displayed on the scope. Type N to output all lines in the table. There are usually many more lines than are displayed on the scope because the scope cannot resolve closely adjacent lines.¹

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If the Teletype punch is turned on during a List operation, a binary coded decimal paper tape is produced which may be used as input to CATALCAL (DEC-12-UW1A-D) to produce a spectrum consisting of peaks instead of lines.

5.6 P (PUNCH)

The accumulated spectrum can be punched on the high-speed reader/punch by issuing the punch command.

6.0 OPERATING SUGGESTIONS

A useful starting point for many 60 MHz NMR (hydrogen) spectra of organic molecules is a sweep offset of 0 Hz and a sweep width of 500 Hz. For best results, however, all peaks should eventually be examined at a considerably smaller sweep width, since rounding errors may give misleading scope displays with large sweep widths. It should be noted that increasing the sweep offset moves peaks to the right, and decreasing the sweep offset moves peaks to the left. Once the peaks are observed, the proper sweep offset and width can be determined from the 25 calibration marks placed across the X axis.

For purposes of estimating a logical minimum intensity, remember that the calibration on the scope on the Y axis is always 0 to 1000.

7.0 NMR BACKGROUND

The discussion below assumes that the nuclei being studied are hydrogen, fluorine, carbon-13 or other nuclei of spin 1/2.

Each nucleus in a molecule can be assigned a spin of either α or β . For a system containing n nuclei, there are 2^n spin states possible. Each of these states is called a basic product function. The energy of a basic product function can be calculated from equation 1 below where $s_i = -1/2$ for β spin and $+1/2$ for α spin, v_i is the frequency of absorption in Hz, $T_{ij} = +1/4$ if i and j have the same spin and $-1/4$ if i and j have opposite spin, and J_{ij} is the coupling constant between i and j in cps.

$$1 \quad H_{uu} = \sum_{i=1}^n (s_i v_i + \sum_{j>i} T_{ij} J_{ij})$$

The energy of interaction between two basic product functions is 0 unless both have the same number of α and β spins. When this condition is fulfilled, the interaction energy is calculated from equation 2 where $U=1$ if the basic product functions differ only in the interchange of spins i and j (J_{ij} as defined above). Otherwise, $U=0$.

$$2 \quad H_{uv} = 1/2 U J_{ij}$$

Thus, to calculate an NMR spectrum, one constructs all of the possible basic product functions and sorts them into groups, each member of a group containing the same number of α and β spins. The energy of each of them is determined and used as the diagonal element in a square matrix. The off-diagonal elements of this matrix (H matrix) are energies of interaction between the members of the group. This matrix is diagonalized and these elements then contain the energies of the final spin functions. These final spin eigenfunctions are the columns of the matrix (U matrix) required to diagonalize the H matrix. Each element in a spin function represents the contribution of a basic product function to that spin function.

Before continuing, it is necessary to define the F_z value of a spin function, as shown in equation 3, where s_i is as previously defined.

$$3 \quad F_z = \sum_{i=1}^n s_i$$

Now the peaks observed in NMR spectra are transitions from one spin function to another. These transition energies and their intensities can be calculated as outlined below. Transitions are allowed between spin functions whose F_z values differ only by 1. If this holds, the energy of the transition is the difference in energy of the final spin eigenfunctions, and the intensity of the transition is given by equation 4 where C_u is the u th element in one spin function, C'_v is the v th element in the other spin function, and $A=1$ if the basic product functions represented by C_u and C'_v differ by one spin. Otherwise, $A=\emptyset$.

$$4 \quad I = (\sum_u \sum_v C_u C'_v A)^2$$

8.0 EXAMPLE

The following pages represent an actual printout. The spectra are representations of those displayed on the scope. The underlined data is that typed by the user.

LO NMRSIME, 2

NMRSIM

COMMENTS: DEMO 1

WANT PAPER TAPE I/O? Y

WANT HIGH SPEED READER-PUNCH? Y

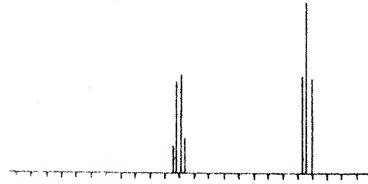
NO. OF SPINS= 5

OFFSET & WIDTH: 0, 500

CHEMICAL SHIFTS: 90, 90, 90, 260, 260

COUPLING CONSTANTS: 0, 0, 8, 8, 0, 8, 8, 8, 8, 0,

BLOCK, U: 400, 3



L:

MIN. INTENSITY: 0

DISPLAY LIST? Y

INTENSITY	ENERGY
27.00	272.00
90.00	264.00
99.00	256.00
36.00	248.00
104.00	97.00
189.00	90.00
86.00	81.00

P:

Q:

OFFSET & WIDTH: 0, 300

TAPE INPUT? Y

BLOCK, U: 420, 3,

MORE? N
P:

NMRSIM

COMMENTS: DEMO 1 CONT

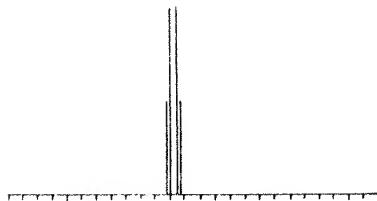
NO. OF SPINS= 2

OFFSET & WIDTH: 0, 500

CHEMICAL SHIFTS: 265, 280

COUPLING CONSTANTS: 5

BLOCK, U: 440, 3



C:

COUPLING CONSTANTS: 10

BLOCK, U: 440, 3

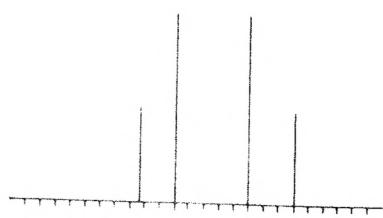
O:

OFFSET & WIDTH: 250, 50

TAPE INPUT? N

BLOCK, U: 440, 3

MORE?N



D:

9.0 ASSEMBLING NMRSIM

The NMRSIM program is supplied to the user in both source and binary on the tape. To generate a new binary file if the source program is modified, use the following procedure.

1. Load a DIAL-MS tape on unit \emptyset . Load unit 1 with either a DIAL-V2 or DIAL-MS system tape. If another tape unit is available, mount the tape containing the CLEARSYM and NMRSIM source programs there. If only two tape units are available, place the source programs on unit \emptyset (with PIP if necessary), in order to reduce the assembly time.

2. Type $\rightarrow ZE$ to clear the binary Working Area of unit 1.
3. Type $\rightarrow AS CLEARSYM$. CLEARSYM is a two word program which produces a clean symbol table.

$\emptyset\emptyset\emptyset$
SAVSYM 1

4. Type $\rightarrow AS NMR2, \emptyset$. Error messages generated at this time should be ignored. Press the RETURN key to terminate the assembly after the errors have all been printed to suppress printing of the symbol table.
5. Type $\rightarrow ZE$. This clears the binary Working Area on unit 1.
6. Type $\rightarrow LI NMR3, \emptyset$. If no listing is desired, use the AS command. Any errors generated now are real and must be corrected.
7. Type $\rightarrow LI NMR2, \emptyset$. Because the symbol table produced is the same as the one generated in step 6, printing may be suppressed with the RETURN key after it has started to be printed.
8. Type $\rightarrow SB NMR23, \emptyset$. This saves the binary output from the two previous assemblies
9. Type $\rightarrow ZE$.
10. Two versions of the Floating Point Package are applied. If the machine has the EAE option, NMRIE should be used in the following steps and NMRSIME will be generated. If the machine does not have this option, NMRII should be used to generate NMRSIM.

11. Type \rightarrow AB NMRL, \emptyset .
12. Type \rightarrow AB NMR23, \emptyset .
13. Type \rightarrow SB NMRSIM, \emptyset P \rightarrow . A binary file of NMRSIM(E) has now been generated and the command \rightarrow LO NMRSIM, \emptyset will cause load and execute.

10.0 INTERNAL DESCRIPTION

The complete program listings are contained at the back of the manual. The following is a brief outline of the program; capital letters below refer to variables.

1. Begins with text mode for input of commentary.
2. Enter the number of spins and store in N.
3. Set "switch" for punched output.
4. Set up basic produce functions (BPFs).
 - A. Calculate NARRY array which contains relative addresses of the BPFs of different F_z value.
 - B. Calculate NUSe array. This array actually contains the BPFs. They are stored in groups, each group having an F_z value one greater than the preceding group.
5. Get sweep offset and sweep width.
6. Get chemical shifts.
7. Get coupling constants.
8. Initialize SPEC array.
 - A. This array eventually contains the displayed spectrum.
 - B. It is initialized to \emptyset except for calibration points where it is set to 4000 \emptyset .
9. Calculate first H and U matrices.
 - A. First H matrix is always a 1 X 1 which does not require diagonalization.
 - B. First U matrix is always a 1 X 1 with its only element equal to 1.
10. Set FLAG which is the negative of the number of times the loop from 11 to 17 must be executed.

11. Set N2, calculate EN and UOLD arrays.
 - A. Copy the trace of the H matrix into the EN array.
 - B. Copy the U matrix into the UOLD array.
 - C. Set N2 equal to the size of the H matrix just copied.
12. Calculate the size of the next H matrix and put in into N1.
13. Determine which transitions will be allowed between the BPFs represented by UOLD and those that will be represented by U. This is stored in the array called TABLE.
14. Initialize H and U matrixes.
 - A. Diagonal H elements are calculated by equation 1.
 - B. Off-diagonal H elements are calculated by equation 2.
 - C. The U matrix is initialized to all zeros except for ones on the diagonal.
15. Diagonalize the H matrix and calculate the U matrix by the Jacobi method.
16. Calculate transitions.
 - A. Calculate transition energies by forming the differences between the elements of the trace of the H matrix and the elements in the EN array.
 - B. Calculate transition intensities from equation 4.
 - C. Store appropriate values in SPEC array.
17. Test FLAG to see if the loop is done.
 - A. If loop is not done, go to 11.
 - B. If loop is done, display spectrum.
18. If ALT MODE is typed, interpret mnemonic and execute option.

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*24

/NMR SPECTRAL SIMULATOR!

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... AS SUBMITTED BY D.F. JUERS, R.W. BOETTCHER, V.J. HULL
... AND H.E. ZIMMERMAN OF UNIV. OF WISC., MADISON, WISC.
/MODIFICATIONS MADE BY G.W. DULANEY OF DEC., MAYNARD, MASS.
/TO ALLOW OPERATION ON THE PDP=12.

PMODE LODSYM

LISTAP =1

FEXT=0000

FADD=1000

FSUB=2000

FMPY=3000

FDIV=4000

FGET=5000

FPUT=6000

FNOR=7000

SQRT=2

FMPY2=3

FDIV2=4

NEGATE=5

FLOIN=6

EXP=44

HORD=45

LORD=46

PMode

JMP I ,+1

BEGIN

HIRED

HPUN,

HIPUN

TABLE,

TABL

READ,

C

KSF

JMP

,-1

KRB

JMP I

READ

C

TSF

JMP

,-1

TLS

JMP I

TYPE

C

*62

0220

5421

JMP I ,+1

BEGIN

HIRED

HPUN,

HIPUN

TABLE,

TABL

READ,

C

KSF

JMP

,-1

KRB

JMP I

READ

C

*62

0221

0222

DECIMAL

10

JMP

I

IFZB,

16

JMP

NUSEB,

23

JMP

CPSB,

87

JMP

CUPB,

125

JMP

BOLD,

710

JMP

ENB,

650

JMP

1212

SPECB,

150

JMP

UB,

1910

JMP

HB,

3110

JMP

OCTAL

PRINT,

PRINTL

JMP

I

JMP

0076 DISPLAY, STDIS
 0077 4103 LNCTAP
 0078 0010 UNIT, 10
 0100 0110 STBLK, 110
 0101 0101 BLK1, 0
 0102 0000 INSWT, 0
 0103 0000 AREND, DATBUF+1=371
 0104 4336 CORBUF, DATBUF=1
 0105 0334 TPGT,
 0106 0000 N,
 0107 0000 TEMP,
 0110 0000 LIMIT,
 0111 0000 Q
 0112 0000 Q
 0113 0000 ADD0,
 0114 0000 TEMP1,
 0115 0000 N1,
 0116 0000 A,
 0117 0000 Q
 0118 0000 Q
 0119 0000 Q
 0120 0000 Q
 0121 0000 B,
 0122 0000 Q
 0123 0000 Q
 0124 0000 FSIN,
 0125 0000 Q
 0126 0000 Q
 0127 0000 FCOS,
 0128 0000 Q
 0129 0000 Q
 0130 0000 Q
 0131 0000 Q
 0132 0000 Q
 0133 0000 N2,
 0134 0000 JTTEMP,
 0135 0000 FACTOR,
 0136 0000 Q
 0137 0000 OFFSET,
 0138 0000 Q
 0139 0000 POND=,
 0140 0000 *200
 0141 0000 CLA 55 /SA OF PROGRAM
 0142 0000 KCC
 0143 0000 TLS
 0144 0000 RFC
 0145 0000 JMS 1 PRINT /NMR SIMULATOR*COMMENTS:
 0146 0000 DCA 55
 0147 0000 BEGIN,
 0148 0000 HD1 READ /ROUTINE ALLOWS USER TO TYPE ANY AMOUNT
 0149 0000 JMS 1 TYPE /OF COMMENTARY AT BEGINNING OF PROGRAM,
 0150 0000 M2010 EXIT IS ACHIEVED BY TYPING CTRL/A,
 0151 0000 HD1 S2A CLA OVERO /GET MORE
 0152 0000 JMS 1 JMP /GET HSR/P AND TAPE SETUP
 0153 0000 DCA .1 IND1 /RETURNED WITH SKP IN AC; NO FURTHER CALLS
 0154 0000 GTSPN JMP GTSPN
 0155 0000 CLA QUEST
 0156 0000 TAD TYPE
 0157 0000 JMS 1 PRINT /NO, OF SPINS=
 0158 0000 HD2 INPUT
 0159 0000 JMS 1 FIXM
 0160 0000 CLL RAR
 0161 0000 JMS 1 PRINT
 0162 0000 HD2 INPUT
 0163 0000 JMS 1 FIXM
 0164 0000 CLL RAR
 0165 0000 JMS 1 PRINT
 0166 0000 HD2 INPUT
 0167 0000 JMS 1 FIXM
 0168 0000 CLL RAR
 0169 0000 JMS 1 PRINT
 0170 0000 HD2 INPUT
 0171 0000 JMS 1 FIXM
 0172 0000 CLL RAR
 0173 0000 JMS 1 PRINT
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 0201 0000 JMS 1 PRINT
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 0205 0000 JMS 1 PRINT
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 0207 0000 JMS 1 FIXM
 0208 0000 CLL RAR
 0209 0000 JMS 1 PRINT
 0210 0000 HD2 INPUT
 0211 0000 JMS 1 FIXM
 0212 0000 CLL RAR
 0213 0000 JMS 1 PRINT
 0214 0000 HD2 INPUT
 0215 0000 JMS 1 FIXM
 0216 0000 CLL RAR
 0217 0000 JMS 1 PRINT
 0218 0000 HD2 INPUT
 0219 0000 JMS 1 FIXM
 0220 0000 CLL RAR
 0221 0000 JMS 1 PRINT
 0222 0000 HD2 INPUT
 0223 0000 JMS 1 FIXM
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 0229 0000 JMS 1 PRINT
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 0231 0000 JMS 1 FIXM
 0232 0000 CLL RAR
 0233 0000 JMS 1 PRINT
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 0257 0000 JMS 1 PRINT
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 0260 0000 CLL RAR
 0261 0000 JMS 1 PRINT
 0262 0000 HD2 INPUT
 0263 0000 JMS 1 FIXM
 0264 0000 CLL RAR
 0265 0000 JMS 1 PRINT
 0266 0000 HD2 INPUT
 0267 0000 JMS 1 FIXM
 0268 0000 CLL RAR
 0269 0000 JMS 1 PRINT
 0270 0000 HD2 INPUT
 0271 0000 JMS 1 FIXM
 0272 0000 CLL RAR
 0273 0000 JMS 1 PRINT
 0274 0000 HD2 INPUT
 0275 0000 JMS 1 FIXM
 0276 0000 CLL RAR
 0277 0000 JMS 1 PRINT
 0278 0000 HD2 INPUT
 0279 0000 JMS 1 FIXM
 0280 0000 CLL RAR
 0281 0000 JMS 1 PRINT
 0282 0000 HD2 INPUT
 0283 0000 JMS 1 FIXM
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 0285 0000 JMS 1 PRINT
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 0287 0000 JMS 1 FIXM
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 0289 0000 JMS 1 PRINT
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 0291 0000 JMS 1 FIXM
 0292 0000 CLL RAR
 0293 0000 JMS 1 PRINT
 0294 0000 HD2 INPUT
 0295 0000 JMS 1 FIXM
 0296 0000 CLL RAR
 0297 0000 JMS 1 PRINT
 0298 0000 HD2 INPUT
 0299 0000 JMS 1 FIXM
 0300 0000 CLL RAR
 0301 0000 JMS 1 PRINT
 0302 0000 HD2 INPUT
 0303 0000 JMS 1 FIXM
 0304 0000 CLL RAR
 0305 0000 JMS 1 PRINT
 0306 0000 HD2 INPUT
 0307 0000 JMS 1 FIXM
 0308 0000 CLL RAR
 0309 0000 JMS 1 PRINT
 0310 0000 HD2 INPUT
 0311 0000 JMS 1 FIXM
 0312 0000 CLL RAR
 0313 0000 JMS 1 PRINT
 0314 0000 HD2 INPUT
 0315 0000 JMS 1 FIXM
 0316 0000 CLL RAR
 0317 0000 JMS 1 PRINT
 0318 0000 HD2 INPUT
 0319 0000 JMS 1 FIXM
 0320 0000 CLL RAR
 0321 0000 JMS 1 PRINT
 0322 0000 HD2 INPUT
 0323 0000 JMS 1 FIXM
 0324 0000 CLL RAR
 0325 0000 JMS 1 PRINT
 0326 0000 HD2 INPUT
 0327 0000 JMS 1 FIXM
 0328 0000 CLL RAR
 0329 0000 JMS 1 PRINT
 0330 0000 HD2 INPUT
 0331 0000 JMS 1 FIXM
 0332 0000 CLL RAR
 0333 0000 JMS 1 PRINT
 0334 0000 HD2 INPUT
 0335 0000 JMS 1 FIXM
 0336 0000 CLL RAR
 0337 0000 JMS 1 PRINT
 0338 0000 HD2 INPUT
 0339 0000 JMS 1 FIXM
 0340 0000 CLL RAR
 0341 0000 JMS 1 PRINT
 0342 0000 HD2 INPUT
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 0358 0000 HD2 INPUT
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 0360 0000 CLL RAR
 0361 0000 JMS 1 PRINT
 0362 0000 HD2 INPUT
 0363 0000 JMS 1 FIXM
 0364 0000 CLL RAR
 0365 0000 JMS 1 PRINT
 0366 0000 HD2 INPUT
 0367 0000 JMS 1 FIXM
 0368 0000 CLL RAR
 0369 0000 JMS 1 PRINT
 0370 0000 HD2 INPUT
 0371 0000 JMS 1 FIXM
 0372 0000 CLL RAR
 0373 0000 JMS 1 PRINT
 0374 0000 HD2 INPUT
 0375 0000 JMS 1 FIXM
 0376 0000 CLL RAR
 0377 0000 JMS 1 PRINT
 0378 0000 HD2 INPUT
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 0755 0000 JMS 1 FIXM
 0756 0000 CLL RAR
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    7004      M7      /NO
    02331     TAD      /WAS IT >6?
    1331     SMA      /YES, NO GOOD
    9232     JMP      ERROR O
    7502     TAD      P7
    J233     SMA      /STORE
    0234     5217     /INITIALIZE NARRAY & NUSE
    5217     TAD      /GET UPPER SPECTRAL LIMIT
    0235     0235     /CHEM SHIFTS;
    1333     DCA      INIT O
    0236     3106     JMS I
    0237     4711     JMS I
    0238     4715     JMS I
    0239     NUDAT,   JMS I
    0240     4715     PRINT
    0241     4474     HDS
    0242     1744     JMS I
    0243     4714     JMS I
    0244     4474     W
    0245     1755     PRINT
    0246     4716     HDS I
    0247     4334     JMS I
    0248     4717     JMS I
    0249     4717     JO
    0250     4717     GTTP
    0251     1100     INPEC
    0252     3101     STBLK
    0253     7201     BLK1
    0254     3133     /RESET TAPE BLOCK
    0255     7001     DCA
    0256     9125     CLA
    0257     1106     IAC
    0258     7041     JTEMP
    0259     1066     DCA
    0260     7041     N1
    0261     3326     /READY TO INITIALIZE EN & BOLD
    0262     1063     TAD
    0263     3327     CIA
    0264     4721     FLAGO
    0265     4723     /SET LOOP
    0266     1727     DCA
    0267     3133     TAD
    0268     2327     CIA
    0269     1133     ADDR O
    0270     2327     TAD
    0271     1133     CIA
    0272     7041     ADDR O
    0273     1727     TAD
    0274     3115     N1
    0275     4722     ALLOW O
    0276     4721     JMS I
    0277     4724     JMS I
    0278     4725     JMS I
    0279     3234     JMS I
    0280     2327     JMS I
    0281     1133     JMS I
    0282     7041     JMS I
    0283     1727     JMS I
    0284     3115     JMS I
    0285     4722     JMS I
    0286     4724     JMS I
    0287     4725     JMS I
    0288     3234     JMS I
    0289     2327     JMS I
    0290     1133     JMS I
    0291     7041     JMS I
    0292     1727     JMS I
    0293     3115     JMS I
    0294     4722     JMS I
    0295     4724     JMS I
    0296     4725     JMS I
    0297     3234     JMS I
    0298     2327     JMS I
    0299     1133     JMS I
    0300     7041     JMS I
    0301     1727     JMS I
    0302     3115     JMS I
    0303     4725     JMS I
    0304     3234     JMS I
    0305     2327     JMS I
    0306     1133     JMS I
    0307     7041     JMS I
    0308     1727     JMS I
    0309     3115     JMS I
    0310     4725     JMS I
    0311     3400     CRLFD
    0312     3127     INIT B
    0313     4515     FIXM,
    0314     0600     ASKM
    0315     4515     ASK,
    0316     0610     W,
    0317     1121     INDIL,
    0318     4400     HUGETO,
    0319     2200     ALLOW O,
    0320     4400     COPY O,
    0321     2200     JAKEO,
    0322     2000     JAKEO,
    0323     2520     JAKEO,
    0324     1200     TRANS ,
    0325     2400     TRANS ,
    0326     0000     FLAGO,
    0273

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0274 . 0000 ADDRO,
 0275 0277 QUEST, 2277
 0276 0330 7771 M7, -7
 2277 0331 7577 M2010, -201
 0332 P7, 7
 0333 0007 GTTP, 0
 0334 0000 GTTP,
 0335 4474 PRINT /BLOCK, U:
 0336 1736 HD4
 0337 4753 JMS I OCIN
 0338 5337 JMP .-1 /ERROR RETURN
 0339 5337 SNA /BLOCK & NOT ALLOWED
 0340 5337 JMP *3
 0341 5337 DCA STBLK
 0342 5337 JMS I INPUT
 0343 5100 JMS I FIXM
 0344 4405 JMS I MSK7
 0345 4712 AND
 0346 0352 DCA UNIT
 0347 3077 JMS I CARTN
 0348 3100 DCA STBLK
 0349 4405 JMS I INPUT
 0350 4710 JMS I FIXM
 0351 0351 5335 AND
 0352 0007 MSK7,
 0353 0353 4200 OCTIN,
 0354 0000 HIRED,
 0355 6011 RSB
 0356 5355 JMP .-1
 0357 6016 RRB RFC
 0358 6020 PSF
 0359 6026 PLS
 0360 6027 HIPUN,
 0361 6028 HIPUN,
 0362 6026 PLU
 0363 6021 PSF
 0364 5363 JMP .-1
 0365 5761 HIPUN
 0366 *400 /PDP
 0400 0002 2 TLS
 0401 6046 OFFS,
 0402 4717 JMS I AULIM
 0403 4474 PRINT /TAPE INPUT?
 0404 1770 HD8
 0405 4716 JMS I ASKMX
 0406 4716 TAD INSWT
 0407 4505 JMS I TPCT
 0408 4716 JMS I INSPA
 0409 4716 TAD INSWT
 0410 4716 SZA CLA
 0411 1102 TAD GET
 0412 7640 DCA STBLK
 0413 5222 BLK1
 0414 1100 GET /NO
 0415 3101 RESET TAPE BLOCK
 0416 6014
 0417 4622 JMS I HRED
 0418 4623 SNA /IS DATA COMING?
 0419 4624 JMP *2 /NO, BLANK TAPE
 0420 4625 JMS I RDWD /YES, READ A CHEMICAL SHIFT
 0421 5217 GET, JMS I DONIN
 0422 4527 JMS I INTERP
 0423 5267 FADD LIMIT
 0424 4407 FADD FACTOR
 0425 1110 FADD /SCALE
 0426 5134 HALFA
 0427 1320 FEXT
 0428 0000 JMS I FIXA /FIX IT
 0429 0000 JMS I SPECAD
 0430 0000 DCA ROWD /GET CORRESPONDING INTENSITY
 0431 4723 JMS I ROWD /CAN ONLY GET HEP BY ERROR
 0432 3324 JMS I HLT /FIX IT
 0433 4327 JMS I FIXA /DONGA
 0434 54 JMS I
 0435 7402 JMS I
 0436 4723 JMS I
 0437 54 JMS I
 0438 4723 JMS I
 0439 54 JMS I
 0440 54 JMS I

0437 TAD SPECAD /IN RIGHT RANGE
 0440 SPA /NO, LOOK AT NL, ONE
 0441 JMP GET /MAYBE
 0442 TAD M500 /IN RIGHT RANGE?
 0443 SMA CLA GET /NO, LOOK NEXT CASE
 0444 TAD SPECAD /YES, ADDRESS IN SPEC ARRAY
 0445 TAD SPECB /YES, ADDRESS IN SPEC ARRAY
 0446 TAD SPECAD /SPECAD
 0447 DCA CDF 10
 0448 TAD I SPECAD
 0449 RAL /SET BIT 0 TO 0
 0450 CLL RAR TAD APROB
 0451 1325 SMA CLA /OVERFLOW?
 0452 1326 JMP :+6 /NO
 0453 1327 TAD I SPECAD /YES, SET TO MAX
 0454 1328 RAL /SET BIT 0 TO 0
 0455 1329 DCA I SPECAD /STORE
 0456 1330 GET /LOOK NEXT CASE
 0457 1331 JMP :+6 /NO
 0458 1332 TAD I SPECAD /YES, SET TO MAX
 0459 1333 APROB /INCREMENT CURRENT VALUE
 0460 1334 *4
 0461 1335 JMS I PRINT /MORE?
 0462 1336 HD3
 0463 1337 SZA CLA ASKMX
 0464 1338 NMRE
 0465 1339 TAD INSWT /YES
 0466 1340 SNA CLA /PAPER?
 0467 1341 GET 4 /YES
 0468 1342 JMS I TPGT /NO, LINCTAPE; GET BLOCK , UNIT
 0469 1343 5000 4715 TPSTR /INIT. TAPE AND BUFFER
 0470 1344 5001 5222 TAD GET
 0471 1345 5002 4714 NMRE, CARLFD
 0472 1346 5003 1102 TAD INSWT
 0473 1347 5004 7640 SZA CLA DISPLAY
 0474 1348 5005 5475 JMS I DISPLAY /INSERT TAG WORD
 0475 1349 5006 7133 STL IAC RTR /INSERT TAG WORD
 0476 1350 5007 6201 CDF 0
 0477 1351 3411 DCA I 11
 0478 1352 0511 TAPTRN /WRITE OUT LAST BUFFER
 0479 1353 4776 JMS I DISPLAY /DISPLAY
 0480 1354 0512 5475 JMP 1
 0481 1355 0513 ASKMX, CARLFD
 0482 1356 0514 2663 STRTP
 0483 1357 0515 3317 TPSTR, INSPA,
 0484 1358 0516 1121 AULIM,
 0485 1359 0517 5554 HALFA,
 0486 1360 0518 2000 2000
 0487 1361 2522 2000 0
 0488 1362 2523 3127 FIXA, FIX
 0489 1363 2524 0000 SPECAD, 0
 0490 1364 2525 0000 APROB, 0
 0491 1365 2526 0000 DECIMAL
 0492 1366 2527 0500, -500
 0493 1367 2528 OCTAL
 0494 1368 RDWD, 0
 0495 1369 CLA CDF 0
 0496 1370 TAD INSWT

2352 FLAGC /DONE?
 0636 RPTC /NOT GET NEXT ELEMENT
 0572 JMP 10
 0640 CDF 10
 0573 6211 JMP I
 0574 5600 MC /YES; RETURN
 0575 0642 00000 DIAGC,
 0576 0643 4751 JMS I KLAEL /CLEAR ADD0 (3 WORDS)
 0577 0644 1065 TAD CPSB /ADDRC INITIALIZED TO CPS
 0600 0645 3356 DCA ADDRCC /CUPB
 0601 0646 1066 TAD ADDRC1 /ADDRC1 INITIALIZED TO CUP
 0602 0647 3357 DCA N
 0603 0650 1106 TAD
 0604 0651 7041 CIA
 0605 0652 5352 DCA /SET CPS DO LOOP
 0606 0653 1107 TAD TEMP /GET BPF
 0607 0654 3324 DCA TEMC /STORE IN TEMC
 0610 0655 7300 RPTC1,
 0611 0656 1354 CLL
 0612 0657 7010 TAD TEMC /GET RIGHTMOST BIT
 0613 0660 3354 DCA TEMC /STORE REDUCED BPF
 0614 0661 1354 TAD TEMC /STORE FOR J USE
 0615 0662 3355 DCA TEMC1.
 0616 0663 7430 SZL /ALPHA OR BETA?
 0617 0664 5272 JMP *+6
 0620 0665 1346 TAD BETA /BETA SPIN
 0621 0666 5300 DCA ORDER /SET DIRECTIONS
 0622 0667 1350 TAD CASE1
 0623 0670 5320 DCA DIRC /SET DIRECTIONS FOR JS
 0624 0671 5276 TAD ALPHA
 0625 0672 1344 ORDER *+5
 0626 0673 3300 DCA ORDER /SET DIRECTIONS
 0627 0674 1263 TAD CASE2
 0630 0675 3320 DCA DIRC /SET DIRECTIONS
 0631 0676 4407 JMS I INTERP
 0632 0677 5513 FGET I ADD0 /INCREMENT ELEMENT DEPENDING ON DIRECTIONS
 0633 0700 ORDER, 0
 0634 0701 6213 FPUT I ADD0 /INCREMENT ELEMENT DEPENDING ON DIRECTIONS
 0635 0702 0200 FEXT
 0636 0703 7325 CLA IAC STLRAL
 0637 0704 1356 TAD ADDRCC /INCREMENT ADDRCC
 0640 0705 3356 DCA ISZ /DONE?
 0641 0706 2352 JMP *+3 /NO; CONTINUE
 0642 0707 5312 CDF 10
 0643 0710 6211 CLL
 0644 0711 5642 JMP I DIAGC /YES; RETURN
 0645 0712 1352 TAD FLAGC /ROTATE
 0646 0713 3353 DCA FLAGC1 /SET J DO LOOP
 0647 0714 7300 RPTC2,
 0650 0715 1355 TAD TEMC1 /GET PARTIALLY ROTATED BPF
 0651 0716 7010 RAR
 0652 0717 3355 DCA TEMC1 /STORE ROTATED VALUE
 0653 0720 2000 DIRC, 0 /DEPENDS ON SPIN
 0654 0721 2325 JMP *+4 /SAME AS REFERENCE
 0655 0722 1347 TAD BETA1 /DIFFERENT THAN REFERENCE
 0656 0723 3332 DCA CONTROL /SET INSTRUCTION
 0657 0724 5327 JMP *+3
 0660 0725 1345 TAD ALPH1
 0661 0726 3332 DCA CONTROL /SET INSTRUCTION
 0662 0727 4407 JMS I INTERP
 0663 0730 2513 FGET I ADD0
 0664 0731 1513 FADD I ADD0
 0665 0732 0002 CONTROL, E
 0666 0733 0004 FDIV2 /DEPENDS ON SPIN

FEKT

00670 07355 00000 CLA IAC STL RAL
00671 07356 07357 1357 TAD ADDRC1
00672 07357 3357 DCA ADDRC1 /INCREMENT ADDRESS1
00673 07449 2353 ISZ FLAGC1 /DONE WITH J LOOP?
00674 07441 2353 JMP RPTC2 /NO! REPEAT
00675 07442 5314 JMP RPTC1 /CONTINUE CPS LOOP
00676 07443 5255 FADD I ADDRC
00677 07444 1756 ALPHA, FADD I ADDRC1
00730 07445 1757 ALPH1, FADD I ADDRC1
00731 07446 2756 BE TA, FSUB I ADDRC
00732 07447 2757 BE TA1, FSUB I ADDRC1
00733 0750 CASE1, SNL
00734 0751 1147 KLAEL, CLAEL
00735 0752 0000 FLAGC1,
00736 0753 0000 FLAGC1,
00737 0754 0000 TEMC1,
00738 0755 0000 TEMC1,
00739 0756 0000 ADDRC,
00740 0757 0000 ADDRC1,
00741 0758 0000 ADDRC,
00742 0759 0000 ADDRC1,
00743 0760 0000 FPINP,
00744 0761 6201 CDF 0
00745 0762 4767 JMS I FLIN
00746 0763 1060 TAD 60
00747 0764 7650 SNA CLA
00748 0765 5362 JMP *3
00749 0766 5760 JMP I FPINP
00750 0767 7400 *1000
00751 1000 XTERM,
00752 1001 4547 JMS /3 WORD CLEAR OF ADD0
00753 1002 7240 STA
00754 1003 3313 DCA INDD1
00755 1004 3144 DCA INDD2 /INITIALIZE VARIABLES
00756 1005 7346 CLL STA RTL
00757 1006 3312 DCA CTRDD
00758 1007 1107 TAD TEMP
00759 1010 3315 DCA TEN
00760 1011 1114 TAD TEMP1
00761 1012 3316 DCA TEM1
00762 1013 1106 TAD N
00763 1014 7041 CIA
00764 1015 3520 DCA CLL FLAGD /SET DO LOOP
00765 1016 7300 RPTD,
00766 1017 1315 TAD TEM /EXAMINE 1ST BPF
00767 1018 7010 RAR
00768 1019 3315 DCA SZL TEM /STORE REDUCED VALUE
00769 1020 3315 INSTD,
00770 1021 3315 TAD TESTLINK
00771 1022 7432 INSTD,
00772 1023 5227 JMP *4 /DIRD SHOULD BE SZL
00773 1024 1517 TAD DIRD
00774 1025 3235 DCA SZL
00775 1026 5234 JMP *3
00776 1027 1222 TAD INSTD
00777 1028 3235 UCA DIRD
00778 1029 1231 7140 CLL
00779 1030 1032 1515 TAD RAR
00780 1033 1227 1222 DCA
00781 1034 3316 DIRD,
00782 1035 0000 CONT
00783 1036 5252 CTRDD /SPINS THE SAME, ROTATE AGAIN
00784 1037 1037 *3 JMP ISZ /HOW MANY DIFFERENCES?
00785 1038 5243 *3 JMP +3 /K3 CONTINUE
00786 1039 1100 RET, CUF 10 /TOO MANY, RETURN
00787 1040 6211
00788 1041 1100
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0767 1106 N TAD FLAGD /POSITION OF T! DIFFERENCE
0770 1044 1320 TAD TAD /WHERE TO STORE
0771 1045 2313 ISZ INDD1 /INDD1 HAS A VALUE, STORE INDD2
0772 1046 5251 JMP +3 DCA /STORE IN INDD1
0773 1047 3313 INDD1 /+2
0774 1050 5252 JMP INDD2 /WHOLE BPF EXAMINED?
0775 1051 3314 RPTD /NO, ROTATE AGAIN
0776 1052 2320 ISZ INDD1 /YES, GET ADDRESS OF RELEVANT J
0777 1053 5216 TAD
0778 1054 1513 CIA
0779 1055 7041 TAD
0780 1056 1514 TAD
0781 1057 3314 DCA INDD2
0782 1058 1513 TAD INDD2
0783 1059 7041 CIA
0784 1060 3313 DCA INDD1
0785 1061 7041 CIA
0786 1062 3313 DCA INDD1
0787 1063 7040 CMA N
0788 1064 1106 TAD
0789 1065 7041 CIA
0790 1066 3320 DCA FLAGD INDD1
0791 1067 2313 ISZ INDD1
0792 1068 2313 ISZ INDD1
0793 1069 5275 JMP +2
0794 1070 5275 JMP +4
0795 1071 1512 TAD
0796 1072 1320 TAD FLAGD
0797 1073 2320 FLAGD
0798 1074 5267 JMP +5
0799 1075 7041 CIA
0800 1076 1514 TAD
0801 1077 3312 DCA CTRDD
0802 1078 1512 TAD
0803 1079 1512 TAD
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0835 1111 1512 TAD
0836 1112 2000 CTRDD, 0
0837 1113 2000 INDD1, 0
0838 1114 2000 INDD2, 0
0839 1115 2000 TEM, 0
0840 1116 2000 TEM1, 0
0841 1117 7420 INSTD1, SNL
0842 1118 2000 FLDG, 0
0843 1119 2000 INSPEC, 0
0844 1120 2000 INSPEC, 0
0845 1121 2000 CDF, 10
0846 1122 6211 STA
0847 1123 7240 DCA TEM
0848 1124 3515 TAD SPECB
0849 1125 1346 DCA CTRDD
0850 1126 3520 DCA TEM
0851 1127 1071 TAD SPECB
0852 1128 3512 DCA CTRDD
0853 1129 2315 AGAIN, 1 ISZ TEM
0854 1130 5336 SNL *+4
0855 1131 2315 SNL TAD M20
0856 1132 5336 SNL DCA STLR
0857 1133 1345 DCA RAR
0858 1134 3315 DCA I CTRDD
0859 1135 7130 DCA ISZ
0860 1136 3712 DCA
0861 1137 2312 DCA
0862 1140 2320 DCA

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4744 JMS ! INITAP
 1142 JMP ! INSPEC /RETURN
 1267 5721 INTAP,
 1143 3317 STRTP
 1070 7754 M20,
 1144 7754 7014
 1971 1145 M5000D,
 1146 7014 0
 1072 1147 0000 CLAEL,
 1073 1150 6211 CDF 12
 1074 1151 7240 STA
 1075 1152 1113 ADD0
 1176 1153 3010 DCA 12
 1177 1154 3410 DCA 10
 1130 1155 3410 DCA 10
 1101 1156 3410 DCA 10
 1102 1157 6201 CDF 0
 1103 1160 5747 JMP I CLAEL
 1104 1161 0000 ENDCHK, 0
 1105 1162 7300 CLA CLL
 1106 1163 1011 TAD 11
 1107 1164 1103 AREND
 1110 1165 7710 SPA CLA
 1111 1166 5761 JNP I ENDCHK
 1112 1167 4476 JMS I TAPTRN
 1113 1168 1170 TAD CORBUF
 1114 1171 3011 DCA 11
 1115 1172 5761 JMP I ENDCHK
 1117 *1200
 1120 JAKE,
 1121 RPTE,
 1122 1200 CLA
 1123 1202 TAD N1
 1124 1203 CIA
 1125 1205 0
 1126 1206 1115 CIA
 1127 1207 3267 FLAG
 1128 1208 3270 /SET DO LOOP
 1129 1209 3365 CIA
 1130 1210 7200 CTRE
 1131 1211 7200 IS
 1132 1212 2365 CLA
 1133 1213 5222 FLAG
 1134 1214 3270 /LOOP DONE?
 1135 1215 7450 JNP I NO, CONTINUE
 1136 1216 2600 SNA /YES, MATRIX DIAGONALIZED?
 1137 1217 5201 JNP I JAKE /YES, RETURN
 1140 1220 1267 TAD /NO, GO THROUGH AGAIN
 1141 1221 7041 CTRE
 1142 1222 3265 CIA
 1143 1223 TAD R2
 1144 1224 3364 INSTE
 1145 1225 2265 RPTE1, FLAG1 /DONE WITH INNER LOOP?
 1146 1226 5234 JNP I +6 NO, CONTINUE
 1147 1227 7240 CLA /YES, INCREMENT CTRE AND OUTER DO LOOP
 1154 1230 1257 TAD CTRE
 1151 1231 3267 CIA /CTRE=CTRE-1
 1152 1232 1366 TAD R1
 1153 1233 3364 INSTE TEMP
 1154 1234 7200 CLA N1
 1155 1235 1257 TAD FLAG
 1156 1236 1365 TAD TEMP
 1157 1237 3107 TAD N1
 1160 1240 1115 TAD FLAG1
 1161 1241 1265 DCA TEMP
 1162 1242 3114 HSUBE
 1163 1243 4273 UMS
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1165      1245      TAD      TESTE      /ADD 13 TO EXPONENT
1166      1246      SPA      INSTE     /ELEMENT SMALL, OUGH?
1167      1247      JMP I    INSTE     /YES, LOOK FOR OTHER
1168      1250      ISZ      ADD0     /IS IT 0?
1169      1251      CLA      CLL      ADD0
1170      1252      TAD I    ADD0
1171      1253      RAL
1172      1254      SNA
1173      1255      JMP I    INSTE     /ITS 0
1174      1256      STA      /RESTORE ADD0
1175      1257      TAD
1176      1258      DCA
1177      1259      ADD0
1178      1260      ADD0
1179      1261      ISZ      /SHOW THAT A LARGE ELEMENT IS FOUND
1180      1262      JMS I    TRIGE
1181      1263      JMS I    /0 THE ELEMENT
1182      1264      VALUE
1183      1265      JMP I    INSTE     /CONTINUE
1184      1266      0000
1185      1267      0015      TESTE, 15
1186      1268      0000      CTR, 0
1187      1269      0000      IS, 0
1188      1270      0000      TRIG, TRIG
1189      1271      1400      FLAG1,
1190      1272      1600      VALUE,
1191      1273      0000      HSUBE, 0
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0000 FEXT JMS I
1363 1452 453 TR1,
1364 454 5324 INTERP
1365 455 4324 Y
1366 1455 4324 FGET R
1367 1456 6321 FDIV Y
1370 1457 5337 /Y(FCOS2)=Y/R
1371 1460 0003 FGET HJK
1372 1461 4324 FMPY2
1373 1462 6324 FDIV R
1374 1463 5316 /R(FSIN2)=2*HJK/R
1375 1464 1521 ONEF
1376 1465 0004 FADD Y
1377 1466 0002 FDIV2
1400 1467 6127 SQRT
1401 1470 5324 FCOS
1402 1471 4127 FPUT R
1403 1472 0004 FSIN
1404 1473 6124 FGET HJJ
1405 1474 5331 FDIV
1406 1475 1334 FADD HKK
1407 1476 0004 FDIV2
1410 1477 6116 FSIN=FSIN2/FCOS/2
1411 1500 5337 FPUT A
1412 1501 3524 FGET HJK
1413 1502 6121 FPUT R
1414 1503 5331 FGET HJJ
1415 1504 2334 FSUB HKK
1416 1505 0004 FDIV2
1417 1506 3321 FMPY Y
1420 1507 2121 FSUB B
1421 1510 6121 FPUT B
1422 1511 3220 FEXT
1423 1512 1327 TAD JF
1424 1513 3107 DCA TEMP
1425 1514 6211 CDF 10
1426 1515 5600 JMP I
1427 1516 0001 TRIG
1430 1517 2000 /RETURN
1431 1520 2000
1432 1521 0000 Y, 2
1433 1522 0000 Y1, 0
1434 1523 0000 0, 0
1435 1524 0000 R, 0
1436 1525 0000 0, 0
1437 1526 0000 0, 0
1440 1527 2000 JF,
1441 1530 0000 KF, 0
1442 1531 0000 HJJ, 0
1443 1532 0000 0, 0
1444 1533 0000 0, 0
1445 1534 0000 HKK, 0
1446 1535 0000 0, 0
1447 1536 0000 0, 0
1450 1537 0000 HJK, 0
1451 1540 0000 0, 0
1452 1541 0000 0, 0
1453 1542 1273 HSUBF, HSUBE
1454 1543 0000 ONESET, 0
1455 1544 7240 STA
1456 1545 1113 TAD ADD0
1457 1546 3010 DCA 10
1461 1547 6211 RNF 10

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1462      DCA I   10
1463      STL RTR
1464      DCA I   10
1465      DCA I   10
1466      CDF 0
1467      JMP I   ONESET
1472      TEXT4=, /TEXT4 LOADS
1471      *1600, 0
1472      00000, 0
1473      1601 72000, CLA TEMP
1474      1602 1107, TAD JG
1475      1603 3262, DCA TEMP1
1476      1604 1114, TAD K
1477      1605 3263, DCA N1
1502      1606 1115, TAD
1521      1607 7041, CIA
1502      1610 5264, DCA FLAGG
1523      1611 6201, CDF 0
1504      1612 7201, CLA IAC FLAGG
1505      1613 1264, TAD N1
1506      1614 1115, DCA TEMP
1527      1615 3107, TAD USUBG
1512      1616 1261, DCA SUBG
1511      1617 3256, TAD JMS
1512      1620 4273, TAD EL
1245      1621 1260, DCA HSUBG
1514      1622 5256, DCA SUBG
1515      1623 4273, DCA SUBG
1510      1624 2264, TAD JMS
1517      1625 5212, TAD ISZ
1526      1626 1263, DCA HSUBG
1527      1627 5127, DCA SUBG
1522      1632 4662, DCA SUBG
1523      1631 4427, DCA INTERP
1524      1632 2116, FPUT I A
1525      1633 2121, FSUB B
1526      1634 0513, FPUT I ADD0
1527      1635 2022, FEXT A
1532      1636 1262, TAD JC
1531      1637 3127, DCA TEMP
1532      1640 1262, TAD JC
1533      1641 3114, DCA TEMP1
1534      1642 4660, DCA HSUBG
1535      1643 4427, JMS I
1536      1644 2116, FGET A
1537      1645 1121, FADD B
1538      1646 0513, FPUT I ADD0
1539      1647 2022, FEXT
1540      1650 1263, TAD K
1541      1651 3114, DCA TEMP1
1542      1652 4662, DCA HSUBG
1543      1653 4657, JMS I
1544      1654 4427, KREL
1545      1655 1121, CDF 12
1546      1656 2127, JMP I
1547      1657 4657, VALUEG
1548      1658 2022, K
1549      1659 4427, KREL
1550      1660 1273, CLAEL
1551      1661 1041, HSUBG
1552      1662 0000, USUBG
1553      1663 0000, JG,
1554      1664 0000, K,
1555      1665 0000, FLAGG,
1556      1666 0000, LK,
1557      1667 0000, K,
1558      1668 0000, LK,
1559      1669 0000, K,
1560      1670 0000, LK,

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1561 0000 0000 L.J.,
 1562 1670 0000 0000 0
 1563 1671 0000 0000 0
 1564 1672 0000 0000 0
 1565 1673 0000 0000 0
 1566 1674 1263 TAD K
 1567 1675 5114 DCA JMS I
 1568 1676 4656 SUBG
 1569 1677 4407 INTERP
 1570 1700 5513 FGET I
 1571 1701 6265 FPUT ADD0
 1572 1702 2000 FEXT LK /LK=M(L,K)
 1573 1703 1262 TAD
 1574 1704 5114 DCA TEMP1 /GET ADDRESS OF M(L,J)
 1575 1705 4656 JMS I
 1576 1706 4407 JMS I
 1577 1707 5513 FGET I
 1578 1708 5270 ADD0
 1579 1710 6270 FPUT L.J.
 1580 1711 5265 FGET LK
 1581 1712 3124 FMPY FFSIN
 1582 1713 6513 FPUT I ADD0
 1583 1714 5270 FGET L.J.
 1584 1715 5127 FMFY FCOS
 1585 1716 2513 FSUB I ADD0
 1586 1717 6513 FPUT I ADD0
 1587 1718 0000 FEXT /M(L,J)=LK*FSIN
 1588 1719 1263 TAD K
 1589 1720 3114 DCA TEMP1 /GET ADDRESS OF M(L,K)
 1590 1721 4656 JMS I
 1591 1722 4407 JMS I
 1592 1723 5265 INTERP
 1593 1724 4407 FGET LK
 1594 1725 5265 FMFY FCOS
 1595 1726 3127 FPUT LK
 1596 1727 6265 FGET L.J.
 1597 1728 5270 FMFY FSIN
 1598 1729 5124 FADD LK
 1599 1730 6513 FPUT I ADD0
 1600 1731 0000 FEXT /M(L,K)=M(L,J)*FSIN+M(L,K)*FCOS
 1601 1732 1265
 1602 1733 6513
 1603 1734 0000
 1604 1735 5673 EL TEXT2,
 1605 1736 *2000 ALLOW, /TEXT2 LOADS
 1606 2000 0000 CLA IAC N2
 1607 2001 7201 TAD
 1608 2002 1132 CIA
 1609 2003 7041 TAD /JTEMP=N2=1
 1610 2004 1133 CIA
 1611 2005 1264 TAD NUSeB
 1612 2006 5334 ADD2
 1613 2007 2004 TAD /CONTAINS ADDRESS OF BPF2
 1614 2008 5330 DCA TABLE
 1615 2009 2011 TABAOH /INITIALIZE TABAOH
 1616 2010 5331 TAD M12H
 1617 2011 2012 DCA CTRH3 /INITIALIZE CTRH3
 1618 2012 3332 TAD N2
 1619 2013 1132 CIA FLAGH /SET OUTER LOOP
 1620 2014 7041 CIA JTEMP
 1621 2015 5505 DCA NUSeB
 1622 2016 7240 RPTH, ADD1
 1623 2017 1133 TAD /ADDRESS OF BPF1
 1624 2018 5505 DCA N1
 1625 2019 7041 CIA FLAGH1 /SET INNER LOOP
 1626 2020 3536 DCA CTRH1
 1627 2021 6214 CTRH2

1660 1634 ADDC
 2026 2027 3340 /GET BPF2
 1661 2030 1733 ADD1
 1662 2031 3337 ADD1
 1663 2032 6201 /GET BPF1
 1664 2033 2333 ADD1
 1665 2034 4257 TEST
 1666 2035 2336 JMS
 1667 2036 5225 RPLH
 1670 2037 2335 FLAG1
 1671 2040 2255 FLAG1
 1672 2041 1332 INC
 1673 2042 7041 TAD
 1674 2043 1331 CIA
 1675 2044 7650 TAD
 1676 2045 5253 SNA
 1677 2046 1730 CLA
 1700 2047 7110 RETH
 1701 2050 2332 RAR
 1702 2051 5247 CTRH3
 1703 2052 5730 CDF
 1704 2053 6211 TABADH
 1705 2054 5600 TABADH
 1706 2055 2334 /YES, RETURN
 1707 2056 2334 INC,
 1710 2056 5216 ADD2
 1711 2057 0000 RPTH
 1712 2060 1106 TEST,
 1713 2061 7041 N
 1714 2062 6341 CIA
 1715 2063 7001 DCA
 1716 2064 7040 TABADH
 1717 2065 3342 CLL
 1720 2066 7500 OVER,
 1721 2067 1537 TABADH
 1722 2070 7010 CTRH1
 1723 2071 3337 BPF1
 1724 2072 7430 CLL
 1725 2073 5277 BPF1
 1726 2074 1343 /STORE ROTATED VALUE
 1727 2075 3305 /TEST LINK AND SET UP LATER TEST
 1730 2076 5301
 1731 2077 1272
 1732 2102 3305
 1733 2101 7100
 1734 2102 1340
 1735 2103 1010
 1736 2104 3340
 1737 2105 0000
 1740 2106 5313
 1741 2107 2342
 1742 2110 5313
 1743 2111 7300
 1744 2112 5317
 1745 2113 2341
 1746 2114 5266
 1747 2115 7200
 1752 2116 1120
 1751 2117 1730
 1752 2120 7010
 1753 2121 3730
 1754 2122 2332
 1755 2123 5657
 1756 2124 2330
 1660 1634 ADDC
 2026 2027 3340 /FIND OUT IF ALLOWED TRANSITION
 1661 2030 1733 /DONE WITH INNER LOOP?
 1662 2031 3337 /NO, CONTINUE
 1663 2032 6201 /YES, DONE WITH OUTER LOOP?
 1664 2033 2333 /NO, CONTINUE
 1665 2034 4257 /IS LAST TABLE ENTRY NORMALIZED?
 1666 2035 2336
 1667 2036 5225
 1670 2037 2335
 1671 2040 2255
 1672 2041 1332
 1673 2042 7041
 1674 2043 1331
 1675 2044 7650
 1676 2045 5253
 1677 2046 1730
 1700 2047 7110
 1701 2050 2332
 1702 2051 5247
 1703 2052 5730
 1704 2053 6211
 1705 2054 5600
 1706 2055 2334
 1707 2056 2334
 1710 2056 5216
 1711 2057 0000
 1712 2060 1106
 1713 2061 7041
 1714 2062 6341
 1715 2063 7001
 1716 2064 7040
 1717 2065 3342
 1720 2066 7500
 1721 2067 1537
 1722 2070 7010
 1723 2071 3337
 1724 2072 7430
 1725 2073 5277
 1726 2074 1343
 1727 2075 3305
 1730 2076 5301
 1731 2077 1272
 1732 2102 3305
 1733 2101 7100
 1734 2102 1340
 1735 2103 1010
 1736 2104 3340
 1737 2105 0000
 1740 2106 5313
 1741 2107 2342
 1742 2110 5313
 1743 2111 7300
 1744 2112 5317
 1745 2113 2341
 1746 2114 5266
 1747 2115 7200
 1752 2116 1120
 1751 2117 1730
 1752 2120 7010
 1753 2121 3730
 1754 2122 2332
 1755 2123 5657
 1756 2124 2330
 1660 1634 ADDC
 2026 2027 3340 /FIND OUT IF ALLOWED TRANSITION
 1661 2030 1733 /DONE WITH INNER LOOP?
 1662 2031 3337 /NO, CONTINUE
 1663 2032 6201 /YES, DONE WITH OUTER LOOP?
 1664 2033 2333 /NO, CONTINUE
 1665 2034 4257 /IS LAST TABLE ENTRY NORMALIZED?
 1666 2035 2336
 1667 2036 5225
 1670 2037 2335
 1671 2040 2255
 1672 2041 1332
 1673 2042 7041
 1674 2043 1331
 1675 2044 7650
 1676 2045 5253
 1677 2046 1730
 1700 2047 7110
 1701 2050 2332
 1702 2051 5247
 1703 2052 5730
 1704 2053 6211
 1705 2054 5600
 1706 2055 2334
 1707 2056 2334
 1710 2056 5216
 1711 2057 0000
 1712 2060 1106
 1713 2061 7041
 1714 2062 6341
 1715 2063 7001
 1716 2064 7040
 1717 2065 3342
 1720 2066 7500
 1721 2067 1537
 1722 2070 7010
 1723 2071 3337
 1724 2072 7430
 1725 2073 5277
 1726 2074 1343
 1727 2075 3305
 1730 2076 5301
 1731 2077 1272
 1732 2102 3305
 1733 2101 7100
 1734 2102 1340
 1735 2103 1010
 1736 2104 3340
 1737 2105 0000
 1740 2106 5313
 1741 2107 2342
 1742 2110 5313
 1743 2111 7300
 1744 2112 5317
 1745 2113 2341
 1746 2114 5266
 1747 2115 7200
 1752 2116 1120
 1751 2117 1730
 1752 2120 7010
 1753 2121 3730
 1754 2122 2332
 1755 2123 5657
 1756 2124 2330
 1660 1634 ADDC
 2026 2027 3340 /SPINS THE SAME
 1661 2030 1733 /DIFFERENT
 1662 2031 3337 /TOO MANY DIFFERENCES
 1663 2032 6201 /ONE ROTATING?
 1664 2033 2333 /NO, ROTATE AGAIN
 1665 2034 4257 /YES, ALLOWED TRANSITION
 1666 2035 2336 /STORES ALLOWEDNESS
 1667 2036 5225 /NEED TO INCREMENT ABAD?
 1668 2037 2337 /NO

1757 2129 1531 TAD M12H
1760 2126 3532 DCA CTRH3
1761 2127 2657 JMP I TEST
1762 2130 0000 TABADH, 0
1763 2131 7764 M12H, 7764
1764 2132 0000 CTRH3, 0
1765 2133 0000 ADD1, 0
1766 2134 0000 ADD2, 0
1767 2135 0000 FLAGH, 0
1770 2136 0000 FLAGH1, 0
1771 2157 0000 BPF1, 0
1772 2140 0000 BPF2, 0
1773 2141 0000 CTRH, 0
1774 2142 0000 CTRH1, 0
1775 2143 7420 NLINK, SNL
1776 2144 0000 0
1777 2145 0000 TABL, 0
2000 SAVSYM 2

*20

P MODE
LCDSYM
LISTAP = 1

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*2200 HUGET,
  0000 2200 0000 STA
  0001 2201 7240 STAD JTEMP
  0002 2202 1133 NUSEB /CONTAINS ADDRESS OF 1ST BPF
  0003 2203 1064 TAD ADDR0
  0004 2204 3247 DCA HB
  2205 2205 1073 TAD ADDR0
  2206 2206 5113 DCA ADD0
  2207 2207 1115 TAD N1
  0015 2210 7041 CIA
  2211 3245 DCA IAC ICTR1 /SET DO LOOP
  0017 2212 7201 RPTI, CLA IAC ADDR0 /ADDRESS OF 2ND BPF
  0022 2213 1247 TAD ADDR0
  0021 2214 3250 DCA ADDR0
  2222 2215 1647 TAD ! ADDR0
  2223 2216 3107 DCA TEMP /CONTAINS BPF
  2224 2217 4651 JMS 1 DIAGEL
  2225 2220 2247 ISZ ADDR0
  2226 2221 2113 ISZ ADD0
  2227 2222 2113 ISZ ADD0
  2228 2223 2113 ISZ ADD0
  2229 2224 7201 CIA
  0032 2225 1245 TAD ICTR1 /WAS THIS THE LAST ELEMENT?
  2230 2226 7450 SNA
  2234 2227 5253 JMP YES, GET U MATRIX
  2235 2230 5246 DCA CTRI /NO, SET INNER LOOP
  0038 2231 7200 CLA IAC ADDR2
  2237 2232 1650 DCA TEMP1 /SECONDARY BPF
  2233 3114 JMS 1 XTERM1 /GET A CROSS TERM
  2241 2234 4652 DCA ADDR0
  2242 2235 2113 ISZ ADDR0
  2243 2236 2113 ISZ ADDR0
  2244 2237 2113 ISZ ADDR0
  0045 2240 2250 ISZ ADDR2 /MOVE TO NEXT SECONDARY BPF
  2246 2241 2246 ISZ ADDR2 /DONE WITH THIS ROW?
  2247 2242 2231 JMP PT12 /NO, CONTINUE
  2251 2243 2245 ISZ ICTRI /YES, INCREMENT LOOP
  0051 2244 2212 RPTI
  2252 2242 0202 ICTRI,
  2253 2246 0202 CTRI,
  2254 2247 0202 ADDR0, 2
  2255 2250 0202 ADDR2, 2
  2256 2251 0242 DIAGEL, XTERM,
  2257 2252 1202 XTERM,
  2258 2253 7202 UGET, CLA
  2259 2254 1115 TAD N1
  2260 2255 7202 CIA
  2261 2256 5246 DCA CTRI
  2262 2257 1115 TAD N1
  2263 2260 2246 ISZ CTRI /LOOP DONE?
  2264 2261 5257 JMP NO, *2
  2265 2262 5246 DCA CTRI
  2266 2263 1246 TAD CTRI
  2267 2264 1246 TAD CTRI
  2268 2265 1246 TAD CIA
  2269 2266 7041 DCA CTRI
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2271 3113 ADD0 /ADDRESS IN U MATRIX
2272 3513 ADD0 /LOOP ZEROES A~ OF U MATRIX
2273 2113 ISZ ADD0
2274 2246 CTRI
2275 5272 ISZ *3
2276 1115 JMP NO
2277 7041 TAD N1
2278 2326 CIA
2279 2301 DCA
2280 2301 CDF 0
2281 2301 OVER1, CLA IAC
2282 2301 TAD CTRI
2283 2303 TAD N1
2284 1115 CIA
2285 2305 DCA TEMP
2286 2306 TAD TEMP1
2287 2307 DCA TEMP1
2288 2307 JHS I USUBI /INDICES OF DIAGONAL U ELEMENT
2289 2310 4717 JMS I GET ADDRESS OF DIAGONAL ELEMENT
2290 2311 4716 SETONE
2291 2312 2246 ISZ
2292 2313 5302 JHS I
2293 2314 6211 CTRI
2294 2315 5600 OVER1 /LOOP DONE?
2295 2316 1543 CDF 10
2296 2317 1341 JMP /NO
2297 2317 USUBI, HUGET
2298 2320 0000 JMP /YES
2299 2321 COPY /RETURN
2300 2321 /SET LOOP
2301 2322 1072 CLA
2302 2323 3247 TAD
2303 2324 1267 DCA ADDR0
2304 2325 3072 TAD BOLD
2305 2326 1247 DCA UB
2306 2327 5067 DCA ADDR0
2307 2330 6221 BOLD
2308 2331 1115 CDF 0 /YES, COPY DIAGONAL H ELEMENTS INTO EN
2309 2332 7041 CIA
2310 2333 1070 CTRI
2311 2334 1070 ENB
2312 2335 5247 CIA
2313 2335 7221 ADDR0 /ADDRESS IN EN
2314 2336 AGAIN1, IAC
2315 2337 1246 TAD CTRI
2316 2338 1115 N1
2317 2341 3107 DCA TEMP
2318 2342 1107 TAD TEMP1
2319 2343 5114 JMS I HSUBI /INDICES OF DIAGONAL H ELEMENT
2320 2344 4763 JMS I INTERP
2321 2345 4407 JHS I ADDR0 /ADDRESS OF DIAGONAL H ELEMENT
2322 2346 5513 FGET 1 ADDR0 /GET H ELEMENT
2323 2347 6647 FPUT 1 ADDR0 /STORE IT
2324 2350 0000 FEXT
2325 2351 2247 ISZ
2326 2352 2247 ISZ
2327 2353 2247 ISZ
2328 2354 2246 ISZ
2329 2355 5336 JMP AGAIN1
2330 2356 7200 CLA
2331 2357 1115 TAD N1
2332 2360 3132 DCA CDF 10
2333 2361 5211 JMP /NO
2334 2362 5120 CLA
2335 2363 1273 HSUBI *2400
2336 2364 2400 TRANS, CDF 0
2337 2365 2401
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0175 1067 BOLD
 TAD 3404 /ADDRESS OF 1ST ELEMENT IN CURRENT OLD
 DCA 3336 EIGENVECTOR
 TAD 1070 /ADDRESS OF OLD EIGENVECTOR
 DCA 3121 /ADDRESS OF OLD EIGENVALUE
 TAD 2405 N2
 DCA 2406 FLAGJ1 /SET 1ST ORDER LOOP
 TAD 2407 UP
 CIA 1132
 DCA 7041
 TAD 5337
 CIA 2411
 DCA 5224
 TAD 2412
 CIA 2413
 DCA 7200
 TAD RPT1,
 CIA 2414
 DCA 2121
 TAD 2415
 CIA 2121
 DCA 2121
 TAD 2416
 CIA 2121
 DCA 2417
 TAD 1132
 CIA 2420
 DCA 1132
 TAD 2421
 CIA 1132
 DCA 2422
 TAD 1336
 CIA 2423
 DCA 3336
 TAD 2424
 CIA 1072
 DCA UP,
 TAD 2425
 CIA 3340
 DCA 2220
 TAD 1115
 CIA 2426
 DCA 7041
 TAD 2427
 CIA 2430
 DCA 3341
 TAD 2431
 CIA 5240
 DCA RPT2,
 TAD 2432
 CIA 7200
 DCA 2433
 TAD 1115
 CIA 2434
 DCA 1112
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 CIA 1115
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 DCA 2444
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 CIA 3114
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0274 13552          CHECK    /GET CHECK WORD
0275 2503           PAR      /PUT CURRENT BYT INTO LINK
0276 2504           DCA      /STORE BALANCE
0277 2505           SNL      /ALLOWED TRANSITION?
0278 2506           JMP     ?+7   /NO, SKIP CALCULATION
0279 2507           4427    /YES, CALCULATE PROBABILITY
0280 2512           5742    JMS 1   INTERP
0281 2511           2512    FGET 1
0282 2511           5742    N2ADD
0283 2511           2512    FMPY 1
0284 2511           2512    FAADD A
0285 2511           2512    FPUT A
0286 2511           2512    FEXT
0287 2511           2512    N1ADD
0288 2511           2512    FPUT
0289 2511           2512    FEXT
0290 2511           2512    ISZ
0291 2511           2512    N1ADD
0292 2511           2512    ISZ
0293 2511           2512    N1ADD /INCREMENT NEW EIGENFUNCTION
0294 2511           2512    ISZ
0295 2511           2512    N1ADD /INCREMENT OLD EIGEN FUNCTION
0296 2511           2512    ISZ
0297 2511           2512    FLAGJ3 /3RD ORDER LOOP DONE?
0298 2511           2512    RPT3 /NO, CONTINUE
0299 2511           2512    ISZ
0300 2511           2512    JMS 1   CALC2 /YES, COMPUTE TOTAL PROBABILITY
0301 2511           2512    ISZ
0302 2511           2512    RPT2 /2ND ORDER LOOP DONE?
0303 2511           2512    RPT1 /NO, CONTINUE
0304 2511           2512    ISZ
0305 2511           2512    RPT1 /1ST ORDER LOOP DONE?
0306 2511           2512    ISZ
0307 2511           2512    RPT1 /NO, CONTINUE
0308 2511           2512    ISZ
0309 2511           2512    COF 10 /YES
0310 2511           2512    TRANS /RETURN
0311 2511           2512    ISZ
0312 2511           2512    N2ADD
0313 2511           2512    ISZ
0314 2511           2512    N2ADD /INCREMENT OLD EIGEN FUNCTION
0315 2511           2512    ISZ
0316 2511           2512    N2ADD /3RD ORDER LOOP DONE?
0317 2511           2512    ISZ
0318 2511           2512    N2ADD
0319 2511           2512    ISZ
0320 2511           2512    FLAGJ3 /NO, CONTINUE
0321 2511           2512    RPT3 /YES, COMPUTE TOTAL PROBABILITY
0322 2511           2512    ISZ
0323 2511           2512    RPT2 /2ND ORDER LOOP DONE?
0324 2511           2512    RPT1 /NO, CONTINUE
0325 2511           2512    ISZ
0326 2511           2512    RPT1 /1ST ORDER LOOP DONE?
0327 2511           2512    ISZ
0328 2511           2512    RPT1 /NO, CONTINUE
0329 2511           2512    ISZ
0330 2511           2512    COF 10 /YES
0331 2511           2512    TRANS /RETURN
0332 2511           2512    ISZ
0333 2511           2512    N2ADD
0334 2511           2512    ISZ
0335 2511           2512    N2ADD
0336 2511           2512    ISZ
0337 2511           2512    FLAGJ1, 0
0338 2511           2512    IN1ADD, 2
0339 2511           2512    ISZ
0340 2511           2512    FLAGJ2, 2
0341 2511           2512    IN1ADD, 2
0342 2511           2512    N2ADD, 2
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0349 2511           2512    CALCM1, 2
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0355 2511           2512    FLAGJ4, 2
0356 2511           2512    N12, =14
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0361 2511           2512    ARRLD, 2
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0363 2511           2512    CHKEND, 1
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0367 2511           2512    ISZ
0368 2511           2512    HORD
0369 2511           2512    ISZ
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0371 2511           2512    ISZ
0372 2511           2512    TAD LORD
0373 2511           2512    DCA 1
0374 2511           2512    ISZ
0375 2511           2512    ARRLD
0376 2511           2512    ISZ
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2714 /EIC
 0473 2712 4520 IWS
 0474 713 7200 CLA
 2714 1/43 TAD I JUMP
 2715 2343 JSZ
 2716 4320 JMS
 2717 5305 JXP
 2720 3000 WRITE AGAIN
 2721 0347 AND
 2722 0342 SNA
 2723 2341 JMP EXITT
 2724 1344 TAD M36
 2725 7550 SPA SNA
 2726 5332 JMP *+4
 2727 1345 TAD P236
 2730 4032 JMS TYPE
 2731 5720 JMP I WRITE
 2732 7440 SZA
 2733 5336 JMP *+3
 2734 4263 JMS CRLF
 2735 5720 JMP I WRITE
 2736 1346 TAD P336
 2737 4232 JMP TYPE
 2740 5676 JMP I PRINTL
 2741 6211 EXITT,
 2742 5676 JMP I
 2743 0000 JUMP,
 2744 7742 M36,
 2745 0236 P236,
 2746 0336 P336,
 2747 0077 MASK1,
 2748 TEXT3=,
 2749 *3000
 3200 CALC1, 0
 3201 4633 JMS I HSUBM
 3202 4407 JMS I INTERP
 3203 5521 FGET I B
 3204 2513 FSUB I ADDI
 3205 0200 FEXT
 3206 4632 JKS I LDARR
 3207 4407 JKS I INTERP
 3210 1110 FADD
 3211 3134 FMRY
 3212 1234 FADD
 3213 0000 FEXT
 3214 4327 JMS
 3215 7512 SPA
 3216 5226 JNP
 3217 1237 TAD
 3220 7500 SMA
 3221 5226 IMP
 3222 1240 TAD
 3223 1271 TAD
 3224 5241 DCA
 3225 5600 JMP I
 3226 7300 CLA CL
 3227 1237 TAD
 3228 3241 DCA
 3229 5600 JMP I
 3230 5241 ARRLD
 3231 3231 HSUBM,
 3232 2554 LDAHR,
 3233 1273 HALFm,
 3234 0000 0
 3235 2000 2000

JMR 1
 /RETURN
 M11 TAD 1361 /IS HORD ALREADY RIGHT?
 SZA *3 NO
 JMP 1 HORD YES, GET HORD
 TAD 1 FIX /RETURN
 SMA 1 /IS TOO BIG TO FIX?
 JMP 1 SET TO 3777
 ERROR NO, SET FIXING LOOP
 DCA HOLD /NO,
 HORD TAD HORD
 CLL SPA /ROTATE RIGHT FILLING WITH 1S IF NEG
 /OR 0S 1F PCS
 STL RAR
 RAR /LOOP DONE?
 ISZ *5 /NO
 JMP 1 /YES RETURN
 CLA 1
 TAD MASKM
 JMP 1 FIX
 7765 *3200
 JMS 1 PRINT /MIN INTENSITY
 HD10 INPUT
 JMS 1 INTERP
 JMS 1 A
 FPUT FEXT
 JMS 1 /DISPLAY LISTING?
 HD9
 JMS 1 ASKRX
 SNA CLA /YES
 JMP 1 DSLST /INIT, TAPE READ
 JMS 1 STRTP /INTENSITY ENERGY
 JMS 1 PRINT
 HD11
 CDF @
 JMS 1 ASKRX
 SNA CLA /NORMAL RETURN
 SKP /FOUND TERMINATOR
 JMP 1 DISPLAY /FOUND TERMINATOR
 JMS 1 INTERP
 NEGATE
 FPUT FSIN
 FEXT
 JMS 1 /GET CORRESPONDING INTENSITY
 SKP /GOT HERE ONLY BY BAD FILE!
 HLT
 JMS EIPRNT
 BACK
 LODFAC /NORMAL RETURN
 JMS 1 DISPLAY /FOUND TERMINATOR
 JMS 1 INTERP
 NEGATE
 FPUT FSIN
 FEXT
 JMS 1 /GET CORRESPONDING INTENSITY
 SKP /NEED NEW BUFFER LOAD?
 SPA CLA AREND /NEED NEW BUFFER LOAD?
 JMP 1 LOCHK /NO
 TAD CORBUF /YES
 11
 DCA IAC
 JMS 1 TAPTRN
 JMS 1 LODFAC. @

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JMS LDCHK
3251 4235 TAD I 11
3252 1411 DCA EXP
3253 3044 STL RTR
3254 7132 SNA CLA LODFAC /GET 6000, 1, E, END WORD?
3255 1044 TAD EXP /YES, INCR, RETURN
3256 7650 ISZ LODFAC
3257 2250 TAD I 11
3260 1411 TAD I 11
3261 3045 DCA HORD
3262 1411 TAD I 11
3263 3046 DCA LORD
3264 5650 JMP I LODFAC
3265 0000 EIPRNT, @ JMS I INTERP
3266 4407 JMS I FPUT
3267 6127 FCOS
3270 2116 FSUB A
3271 0000 FEXT HORD /INTENSITY TOO SMALL?
3272 1045 SPA CLA /YES, GET NEXT VALUES
3273 7710 JMP I EIPRNT /NO, OUTPUT
3274 5665 JMS I INTERP
3275 4407 FGET FCOS
3276 5127 FEXT CLL IAC RAL
3277 0000 FEXT JMS I OUTPUT /OUTPUT INTENSITY
3300 7105 CLL IAC RAL
3301 4406 TAD SPACE
3302 1516 JMS TYPE
3303 4032 JMS TYPE
3304 4032 JMS I INTERP
3305 4407 JMS I FSIN
3306 5124 FGET FEXT
3307 0000 IAC CLL RAL /OUTPUT CHEM SHIFT
3312 7125 JMS I CARLF
3311 4406 JMS I EIPRNT
3312 4714 JMS I CRLFD
3313 5665 JMS I ASKNN,
3314 2663 CARLF,
3315 4315 ASKNN,
3316 0242 SPACE,
3317 0202 STRTP, 0
3320 7200 CLA
3321 1104 TAD
3322 5011 DCA 11
3323 1102 TAD STBLK
3324 3101 IAC
3325 7021 JMS I STRTP
3326 4476 JMS I STRTP
3327 2717 JMS I STRTP
3328 4317 BPNCH, CDF @
3329 5230 TAD
3330 1037 JMS I
3331 6201 JMS I
3332 4364 CDF @
3333 4364 TAD
3334 4423 JMS I
3335 1362 TAD 11
3336 4423 JMS I
3337 5303 DCA TTT
3338 5303 STL RTR
3339 7132 TAD TTT
3340 4235 SNA CLA PEX /GET 6000 FOR END?
3341 1363 JMP TTY /YES
3342 7650 JMS TTY
3343 5353 TAD TTY
3344 1563 JMS TTY
3345 4757 JHS I BPUN
3346 1411 TAD I 11
3347 5343 TAD TTY
3348 4757 JHS I BPUN
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3351 5343 TAD TTY
3352 4757 JHS I BPUN
3353 5353 TAD TTY
3354 1563 JMS TTY
3355 4235 SNA CLA PEX /GET 6000 FOR END?
3356 1411 TAD TTY
3357 5303 DCA TTT
3358 5303 STL RTR
3359 7132 TAD TTT
3360 4235 SNA CLA PEX /GET 6000 FOR END?
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TAD EXP
 NCA EXP
 JMP I DIV02

1044
 3551 3552 3044
 1262 .5553 5747
 1266 3554 2000 ULIMP,
 1267 3555 4474 PRINT /SWEEP OFFSET AND WIDTH;
 1270 3556 2750 HD7
 1271 3557 4405 JMS I INPUT
 1272 3260 4407 JMS I INTERP
 1273 3261 6137 JMS I OFFSET
 1274 3262 6110 FPUT
 1275 3263 0206 FPUT
 1276 3264 6134 FLOIN
 1277 3265 1110 FPUT
 1300 3266 6110 FADD
 1301 3267 5375 FPUT
 1302 3270 4134 FGET
 1303 3274 4134 FDIV
 1304 3571 6134 FACTOR
 1305 3272 0000 FPUT
 1306 3573 6211 CDF 10
 1307 3274 5754 JMP I ULIMP
 1310 3575 0011
 1311 3276 3720
 1312 3577 0200
 1313 *3600 /NMR DISPLAY ROUTINE PART A

1314 3600 STDIS,
 1315 3601 6211 CDF 10
 1316 3602 4326 INITK
 1317 3603 1741 NEXTK,
 1322 3624 0334 TAD I YK /ROUTINE TO COMBINE ADJACENT
 1321 3624 0334 AND K3777 ELEMENTS IN THE SPECBS ARRAY
 1322 3605 7450 SNA /CHECK FOR NON-ZERO ELEMENT
 1323 3606 5237 NINCR
 1324 3607 3344 HOLDK
 1324 3610 2341 YK
 1325 3611 2342 XCTRK
 1327 3612 5214 *+2
 1330 3613 2242 ENDCOM
 1331 3614 1741 TAD I YK /GET NEXT ELEMENT
 1332 3615 0334 K3777
 1333 3616 7450 SNA
 1334 3617 5237 JMP
 1335 3620 1344 TAD HOLDK
 1330 3621 0334 K3777 /COMBINE ELEMENTS
 1336 3622 3344
 1337 3623 1741 TAD I YK /SAVE CALIBRATION MARK
 1340 3624 2335 AND K4000
 1341 3625 1344 TAD HOLDK
 1342 3626 5741 DCA I YK
 1343 5627 7040 CMA
 1345 3630 1341 TAD YY
 1346 3631 0334 DCA YY
 1347 5632 1741 TAD I YY
 1322 5633 0335 AND K4000
 1351 3254 5741 DCA I YY
 1322 5535 2341 ISZ
 1353 5236 5203 NINCR, ISZ
 1324 5637 2341 XCTRK
 1322 3040 2342 NEXTK
 1326 5641 2203 ENDCOM, JMP
 1327 5642 4326 TAD I
 1363 3643 1741 AND K3777
 1364 3644 0334 /ROUTINE TO FIND LARGEST ELEMENT
 1365

2040 2041 2042 2043 2044 2045 2046 2047 2048 2049
 1364 3647 NEXTKV, ISZ YK
 1365 3650 ENDKV, ISZ XCTRK
 1366 3651 ENDKV+1 ISZ ROTATE
 1367 3652 2261 JMP *+2
 1370 3653 1/41 TAD I
 1371 3654 2334 AND YK
 1372 3655 1340 TAD K3777
 1373 3656 7710 SPA CLA
 1374 3657 5247 JMP NEXTKV
 1375 3660 2243 JMP ENDCOM+1
 1376 3661 4326 JMS /ROUTINE TO CHECK FOR OVERSIZED
 1377 3662 3343 DCA ELEMENT AND COMPUTE NUMBER OF
 1400 3663 1340 TAD FLAG
 1401 3664 7041 CIA /ROTATIONS REQUIRED TO PREVENT
 1402 3665 3340 DCA HGT
 1403 3666 1340 AGAINK, HGT
 1404 3667 0336 TAD HGT
 1405 3670 7650 SNA CLA
 1406 3671 5500 JMP OK
 1407 3672 1340 TAD HGT
 1410 3673 0334 AND K3400
 1411 3674 7010 RAR
 1412 3675 3340 DCA
 1413 3676 2343 ISZ
 1414 3677 5266 FLAG
 1415 3700 1343 AGAINK
 1416 3721 7450 TAD FLAG
 1417 3702 5746 SNA /ROTATE ALL ELEMENTS IN ARRAY
 1420 3703 7041 JMP /ANY ROTATIONS NEEDED?
 1421 3704 3343 SNA /NO, EXIT TO DISPLAY
 1422 3722 1343 TAD CLA
 1423 3726 3345 CIA
 1424 3707 1741 TAD FLAG
 1425 3712 0334 AND K3777
 1426 3711 7010 RAR
 1427 3712 0334 AND
 1430 3/13 2345 ISZ
 1431 5714 2311 JMP
 1432 3715 3344 HOLD
 1433 5716 1741 TAD K3777
 1434 3717 0335 AND
 1435 5720 1344 TAD
 1436 3721 3741 HOLD
 1437 5722 2341 DCA YK
 1440 3/23 2342 ISZ
 1441 5724 2305 XCTRK
 1442 3/22 5746 JMP NEXTV
 1443 5725 0230 TAD XSTART
 1444 3/27 1337 INITK,
 1445 5732 3342 TAD ARRLIK
 1446 5731 1271 DCA XCTRK
 1447 5732 3341 TAD SPECB
 1450 5733 5726 DCA YK
 1451 3734 3777 JMP INITK
 1452 3735 4230 DCA *
 1453 3736 3432 K3400, 4200
 1454 3737 7014 ARRLIK, 764
 1455 3740 0000 HGT, 0
 1456 3741 0000 YK, 0
 1457 3742 0000 XCTRK, 0
 1458 3743 0000 FLACK, 0
 1459 3744 0000 CLA, 0

3745 0000 FLGR, START, XSTART, TEXT1=, /TEXT1 LOADS
 3746 4001 *4000 /NMR DISPLAY ROUTINE PART B /OPEN FOR X VALUE FOR LINC DISPLAY
 1466 4000 0000 X, 0, CDF 10 /KEYBOARD INTERRUPT
 1467 4001 6211 KSF /KEYBOARD INTERRUPT
 1468 4002 6031 SKP CLA
 1469 4003 7610 JMP 1 IRRPT
 1470 4004 5702 DCA X
 1471 4005 3200 TAD SPECB
 1472 4006 1071 DCA YP
 1473 4007 5300 DCA RPX*2
 1474 4008 5220 JMP /THE FOLLOWING 7 WORD KLUDGE BOOTSTRAPS DIAL INTO CORE:
 1475 4009 5220 LINC
 1476 4010 5220 LMODE /LDA 1 0
 1477 4011 6141 DIALEX, LINC
 1500 4012 1020 1020 /ESF TO GET I/O PRESET
 1501 4013 0020 0020 /SET LINC DF=3
 1502 4014 0004 0004 /READ TAPE GROUP
 1503 4015 0015 0643 /MUST BE IN LOCN 4017!
 1504 4016 0701 701
 1505 4017 7300 7300
 1506 4018 1273 ARRLIM
 1507 4019 3277 XCTR
 1508 4020 1700 TAD 1 /GET ELEMENT FROM ARRAY
 1509 4021 7440 SZA /CHECK FOR ZERO ELEMENT
 1510 4022 7440 AFMRK+2
 1511 4023 0233 JMP M377
 1512 4024 0233 TAD
 1513 4025 1274 LINC
 1514 4026 6141 LMODE
 1515 4027 0142 DIS 0
 1516 4028 0030 PDP
 1517 4029 0002 PMODE
 1518 4030 7200 CLA INCR
 1519 4031 7200 JMP /CHECK FOR CALIBRATION MARK
 1520 4032 5252 SPA MRKR
 1521 4033 7510 CIA
 1522 4034 5257 DCA
 1523 4035 7041 AFMRK,
 1524 4036 3301 CIA
 1525 4037 1274 TAD M377
 1526 4038 0440 RPY, INKY
 1527 4039 0441 6141 LINC
 1528 4040 0142 LMODE
 1529 4041 0002 DIS 0
 1530 4042 PDP
 1531 4043 0002 PMODE
 1532 4044 2321 ISZ HGTP
 1533 4045 5240 JMP RPY
 1534 4046 1604 LAS /GET Y INCREMENT
 1535 4047 0275 AND KK7
 1536 4048 7001 IAC
 1537 4049 3276 DCA
 1538 4050 2202 INCRT,
 1539 4051 2300 ISZ X
 1540 4052 2254 2277 X
 1541 4053 5222 JMP X
 1542 4054 5222 JMP RPY
 1543 4055 5202 STA RTL /DISPLAY CALIBRATION MARK
 1544 4056 5202 JMP M377
 1545 4057 7346 CLL STA RTL /DISPLAY CALIBRATION MARK
 1546 4058 0050 TAD
 1547 4059 1274 LINC
 1548 4060 6141

4446 2005
2052 4446 2240
2052 4447 2401
2052 4450 2005
2052 4451 4011
2052 4452 5717
2052 4453 7700

2052 4454 2701
2053 4455 1624
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2053 4457 1107
2053 4460 1840
2053 4461 2320
2053 4462 0505
2053 4463 0440
2053 4464 2205
2053 4465 0104
2053 4466 0522
2053 4467 5520
2053 4470 2516
2053 4471 0310
2053 4472 7700

2053 4473 1H01, TEXT \WANT PAPER TAPE 1/0?\\

2054 3747 3616
2055 3750 1522
2055 3751 2311
2055 3752 1536
2055 3753 3603
2055 3754 1715
2055 3755 1505
2055 3756 1624
2055 3757 2372
2055 3760 4000

2055 3761 1517
2056 3762 2205
2056 3763 7700

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2057 3777 4023
2057 3778 2011
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2057 3780 7540
2057 3781 4000

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4000
1753 2372
1754 4000 TEXT /CHEMICAL SHIFTS: /
1755 0317
1756 2520
1757 1411
1760 1607
1761 4003
1762 1716
1763 2324
1764 0116
1765 2423
1766 7240
1767 4000
1770 2401
1771 2005
1772 4011
1773 1620
1774 2524
1775 7700 TEXT /TAPE INPUT?/
1776 0411
1777 2410
1778 7200 TEXT /OFFSET & WIDTH:/
1779 0411
1780 2320
1781 1401
1782 3140
1783 1411
1784 2524
1785 7700 TEXT /DISPLAY LIST?/
1786 1511
1787 1656
1788 4011
1789 1624
1790 2773
1791 0516
1792 2311
1793 2431
1794 7200 TEXT /MIN. INTENSITY:/
1795 3640
1796 4011
1797 1024
1798 0216
1799 1563
1800 2311
1801 2431
1802 4040
1803 4040
1804 4005
1805 1605
1806 1211
1807 2227
1808 7140

2072 HD11, TEXT /↑ INTENSITY ENERGY ↑
 2073 /OVERLAY OF FLOATING POINT PACKAGE 1
 2074 /MUST BE LOADED INTO FIELD 0 AND DATA FIELD MUST BE 0
 2075 /WHEN ENTERING PACKAGE, ALL INDIRECT FLOATING COMMANDS ASSUME
 2076 /THE DATA IS IN FIELD 1.
 2077 *POND

```

2100   INDIR, 0
2101   DCA 1 LOC /ROUTINE SETS DF=1 FOR GETTING
2102   DF,   CDF 10 /DATA ON INDIRECT INSTRUCTIONS
2103   TAD   DF /JMS TO THIS ROUTINE FROM 5626
2104   DCA   CONTRP
2105   JMP   I INDIR
2106   D201 5656 /ROUTINE SETS DF=0 AFTER
2107   0151 0000 /LOADING FAC
2108   0152 7006
2109   D201 5656 /ROUTINE SETS DF=0 AFTER
2110   0153 6201 /LOADING FAC
2111   0154 5251
2112   0155 0000 /ROUTINE SETS DF FOR FPUT
2113   0156 1044
2114   0157 0000 /ROUTINE SETS DF FOR FPUT
2115   0158 5555
2116   0160 5555
2117   0161 0000 /ROUTINE SETS DF BEFORE
2118   0162 7500 /ROUTINE SETS DF=0 BEFORE
2119   0163 6201 /GETTING NEXT INSTRUCTION
2120   0164 5561 /SETS DF=0 FOR STORAGE
2121   0165 1163
2122   0166 3157
2123   0167 5570
2124   0168 5627
2125   0169 5627
2126   0170 5627
2127   0171 5624
2128   0172 5624
2129   0173 5624
2130   0174 5624
2131   0175 5624
2132   0176 5624
2133   0177 5624
2134   0178 5644
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2136   0180 5705
2137   0181 5601
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2142   0186 5601
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2790   070U 5601
2791   070V 5601
2792   070W 5601
2793   070X 5601
2794   070Y 5601
2795   070Z 5601
2796   070A 5601
2797   070B 5601
2798   07
```

```

2170 //IF (.62)=0, OUTPUT FLOATING
2171 //OTHERWISE C(62) = NUMBER OF DIGITS
2172 //C(AAC) = NUMBER OF DECIMAL PLACES
2173 //C(15) LOST DURING EXECUTION
2174 *55
2175 2
2176 2000 *7200
2177 7200 0000 FOUT, 2
2200 7201 3775 DCA ! SCAD /SAVE C(AAC)
2201 7202 1045 TAD HORDER
2202 7203 7110 SPA CLA
2203 7204 1330 TAD SMINUS
2204 7205 1327 TAD SPLUS
2205 7206 4344 JMS ASCOUT /PRINT "SPACE" OR " "
2206 7207 1376 TAD BFRST
2207 7210 3015 DCA 15 /INITIALIZE AUTO-INDEX
2210 7211 5234 /CONVERT MANTISSA AND BUFFER THE DIGITS
2211 7212 1624 JMP 7234
2212 7213 3044 DCA 44 /STORE DECIMAL EXPONENT
2213 7214 4777 JMS 1 FXAD /GO TO OUTPUT THE NUMBER
2214 7215 5223 JMP CRLF /FIXED POINT RETURN
2215 7216 1343 TAD CHE /FLOATING POINT RETURN
2216 7217 4344 JMS ASCOUT /PRINT "E"
2217 7220 7000 NCP
2220 7221 7000 NCP
2221 7222 4737 JMS I EXPX /GO TO OUTPUT EXPONENT
2222 7223 1055 TAD SWT1
2223 7224 6500 SNA CLA /PRINT CR-LF?
2224 7225 5600 JMP 1 FOUT /NO, EXIT
2225 7226 1541 TAD CARRTN /YES
2226 7227 4344 JMS ASCOUT
2227 7230 1342 TAD LNFEED
2230 7231 4344 JMS ASCOUT
2231 7232 5600 JMP 1 FOUT /EXIT
2232 *7375
2233 7375 5655 SCAD, SAC
2234 7376 5666 BFRST, BUFFER=1
2235 7377 5400 FXAD,
2236 *7301 FIXX
2237 7301 3415 *7305 DCA ! 15
2240 7305 3415 *7310 DCA ! 15
2242 7310 5212 HORDER=42
2243 7310 5212 JMP RETN
2244 2245 2246 2247 2248 2249 2250 2251 2252 2253 2254 2255 2256 2257 2258 2259 2260 2261 2262 2263 2264 2265
SMINUS=73352
SPLUS=73277
BEXP=7324
CHE=7343
EXPT=7337
ASCOUT=7344
SWIT15b
CARRTN=7341
LNFEED=7342
// IN THE COMMENTS BELOW:
// F = NUMBER OF DIGITS TO BE OUTPUT
// D = NUMBER OF DECIMAL PLACES
// E = DECIMAL EXPONENT
// P = NUMBER OF PLACES REMAINING TO BE
// PRINTED BEFORE DECIMAL POINT
*5400
Fixx, 2

```

SNA /FLOATING OUTPUT?
 JMP R6 /YES, ROUND OFF TO 6 PLACES
 CIA
 TAD SAC
 SPA /F-D > 0?
 CLA CMA
 TAD 62
 DCA SAC /MAKE D = F-1
 CMA
 TAD 44
 SMA /F-D > E?
 CLA /NO, ROUND OFF TO F PLACES
 TAD 62 /YES
 SPA /D+E < 0?
 JMP PRNT=1 /YES, NO ROUNDING NEEDED, GO TO PRINT
 TAD M6 /NO, ROUND TO D+E PLACES,
 SMA /TO A MAXIMUM OF 6 PLACES
 CLA
 TAD K7 /SAVE NUMBER+1 OF PLACES TO ROUND TO
 DCA TEMPX
 TAD BUFST /SET UP BUFFER ADDRESS AT WHICH
 TAD TEMPX /ROUNDING OFF SHOULD START
 DCA PLCE
 TAD TEMPX
 CIA TEMPX /SET UP COUNT OF MAXIMUM NUMBER
 DCA TEMPX /OF CARRIES ALLOWABLE
 CLL IAC RTL /+4
 ISZ 1 PLCE /ADD 1 TO DIGIT AT CURRENT POSITION
 TAD 1 PLCE
 TAD M10
 SPA CLA /CARRY REQUIRED?
 JMP PRNT /NO, GO TO OUTPUT
 DCA 1 PLCE /YES, MAKE CURRENT DIGIT A ZERO
 ISZ TEMPX /BEGINNING OF BUFFER REACHED?
 JMP DECR /NO, DECREMENT BUFFER ADDRESS AND REPEAT
 ISZ 1 PLCE /YES, SET MANTISSA TO 0,1
 ISZ 44 /COMPENSATE BY INCREMENTING EXPONENT
 CLA
 TAD BUFST /SET AUTO-INDEX REGISTER
 DCA 15
 TAD 62
 SNA /F = 0?
 JMP FLOP /YES, OUTPUT AS FLOATING NUMBER
 CIA
 DCA FCOUNT /SET UP COUNT TO PRINT F PLACES
 TAD FCOUNT
 TAD 44
 SMA SEA /E > F?
 JMP XXX /YES, PRINT XS
 TAD SAC
 SMA /E < F-D?
 CLA /NO, TAKE P = E
 CIA
 TAD 44
 CIA TEMPX /SET UP MINUS P
 DCA M7X
 DCA SCOUNT /SET COUNT OF MAX. NO. OF SIG. FIGS,
 TAD TEMPX
 SNA CLA /P = E?
 LRS RIC

TAD TEMPX /NO,
 TAD IAC /P > 1?
 SPA CLA /YES, TAKE SPACE; OTHERWISE 0
 TAD SPACK /PRINT CHARACTER
 JMS OUTX /PRINT CHARACTER
 ISZ TEMPX /P CHARACTERS PRINTED?
 JMP BACKX /NO
 TAD POINT /YES,
 JMS I/O PUT /PRINT DECIMAL POINT
 JMP BACKX
 CMA
 TAD PLCE
 DCA PLCE
 JMP RETX
 CLA
 TAD CHX
 JMS OUTX /PRINT "X"
 JMP ,=2 /AND REPEAT
 0
 JMS I/O PUT /PRINT CHARACTER
 ISZ FCOUNT /F CHARACTERS PRINTED?
 JMP OUTX /NO, RETURN
 JMP FIXX /YES, NUMBER FINISHED
 CMA
 TAD 44 /REDUCE E BY 1
 DCA 44
 ISZ SCOUNT /6 SIG, FIGS, PRINTED?
 JMP ,=4 /NO
 CMA
 SCOUNT /RESET COUNT TO -1
 JMP IN /AND LEAVE C(AC) = 0
 TAD 1,15 /TAKE NEXT DIGIT FROM BUFFER
 JMP IN
 TAD M6 /SET COUNT TO PRINT
 DCA FCOUNT /6 DIGITS AFTER DECIMAL POINT
 JMS I/O PUT /PRINT "0"
 TAD POINT
 JMS I/O PUT /PRINT " ",
 ISZ FIXX /INCREMENT RETURN ADDRESS
 TAD 1,15 /TAKE NEXT DIGIT FROM BUFFER
 JMS OUTX /PRINT IT
 JMP ,=2 /AND REPEAT
 7
 K7:
 M6, =6
 M10, =12
 BUFFER=1
 T352
 BPUT,
 SPACK,
 242=266
 NTX, =7
 POINT,
 256=268
 CHX,
 330=262
 TEMPX,
 2
 SCOUNT, 2
 FCOUNT, 2
 BUFFER, 2
 PCOUNTFCOUNT
 PAUSECOUNT
 SAVSYM E

0116
ADRB 3533
2

AUDRC 0756
AUDRC1 0757
ADDRL 5
ADDR0 0727
ADDR0 2247
ADDR2 2252
ADDR2 2252
AUD0 0113
ADD1 2133
ADD2 2134
ADSPEC 3041
AFMRK 4035
AGAIN 1131
AGAIN 1131
AGAIN 2336
AGAINK 3666
AGAINL 2705
AHEAD 3026
ALLOW 2000
ALLOWO 0322
ALPHA 0744
ALPH1 0745
ALTR 2530
APROB 0525
AREN0 0103
ARRLD 2554
ARRYIK 3737
ARRLIM 4073
ASCOU7 7344
ASK 0313
ASKI 4443
ASKM 4315
ASKMX 0513
ASKN 3315
ASKRX 3234
AULIM 0517
B 0121
BACK 3217
BACK0 0545
BACKX 5475
BEGIN 0202
BETA 0740
BETA1 0747
BEXP 7324
BFIRST 7376
BLIND 3126
BLK1 0101
BOLD 0267
BPF1 2157
BPF2 2140
BPNCH 3534
BPNJ 3357
BUFFER 5567
BUFS1 5520
CALUM1 3022
CALUM2 3024
CALC1 2545
CALC2 2555
CARLF 3514
CARLFD 0514
CARRTN 7341
CARTN 0310
CASE1 0752
CASE2 0663
CHF 7343

CHLUK 4222
CHKEND 2565
CHRTB 2646
CHTB 2644
CHX 5563
CKEND 0571
CL AEL 1147
CLA IAC 4433
CNT 1052
CONTPR 0157
CONTRO 0732
CONT1 3453
CONT2 3456
CNT3 3467
CONT4 3464
COPY 2320
COPY0 0323
CORBUF 0104
CPSB 0065
CRDC 4142
CRLF 7223
CRLF 2663
CRRTL 4437
CTR 2543
CTR B 3542
CTR DD 1112
CTRE 1267
CTR H 2141
CTR H1 2142
CTR J3 2132
CTR I 2246
CUPB 0266
CARC 4143
CX09 4144
DATAUF 4337
DEC R 5513
DF 0144
DIAGC 0642
DIAGEL 2251
DIALEX 4011
DIFF 1340
DILG 5532
DIR R 0165
DIR C 0722
DIR D 1035
DISPLA 0075
DIV02 3547
DOM 4313
DGVIN 2467
DSLS 4246
DSLST 3233
DSP L 2641
DTFM 4244
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ENUCHK 1161
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FACTOK 0134
FADD '00
FCOS 0127
FCOUNT 5566
FDIV 4000
FDIV2 0004
FEXT 0000
FGET 5000
FIX 3127
FIXA 0523
FIXM 0312
FIXX 5400
FLAGB 3534
FLAGC 0752
FLAGC1 0753
FLAGD 1120
FLAGE 1365
FLAGE1 1265
FLAGG 1664
FLAGH 2135
FLAGH1 2136
FLAGJ1 2537
FLAGJ2 2541
FLAGJ3 2545
FLAGJ4 2550
FLAGK 3743
FLAGO 0326
FLAGR 0572
FLGR 3745
FLIN 0767
FLIN 0006
FLDP 5542
FLOT 4303
FNOR 7000
FOUT 7200
FPINP 0760
FPUT 6000
FSIN 0124
FSUB 2000
FXAD 7377
GET 0422
GTCHR 4203
STSBN 0222
STTP 0334
HALFA 0520
HALFM 3034
HB 0073
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HD10 2767
HD11 1557
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HD3 3761
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HIRED	0354
HJU	1531
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HOLD	3125
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HORD	0045
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HURN	0023
HKED	0022
HSRP	4416
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HSUBF	1542
HSUBG	1660
HSUBI	2363
HSUBM	3033
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KK300 3362
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K7 5553
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LDCHK 3235
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LISP 3200
LJ 1670
LK 1665
LNCTAP 4103
LNFEED 7342
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LODFAC 3250
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MRSRC 4255
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MS17 0352
NY 4334
V11 5555
V12 3161
V12 2551
V124 2131
V122 1145
V2010 0332
V272 2642
V30 2744
V377 4074
V500 0526
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V523M 3037
V6 5554
V7 0331
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A2 1367
A6 5425
SAC 5565
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SIGN 3104
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SMIYUS 7336
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SPECAD 0524
SPECB 0871
PLUS 7327
SQROUT 00022
SQUARE 0001
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STORE 0105
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TEMPX 5564
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x	4277
x	3742
x	4132
x	3740
x	1202
x	2222
x	3517
x	1521
x	3744
y	4222
x	1522
x	2272

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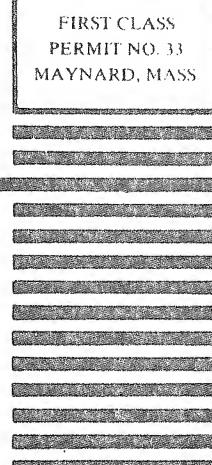
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