SCIENCE AND ENGINEERING RESEARCH COUNCIL

RUTHERFORD & APPLETON LABORATORIES
COMPUTING DIVISION

SUN/14.1

Starlink Project

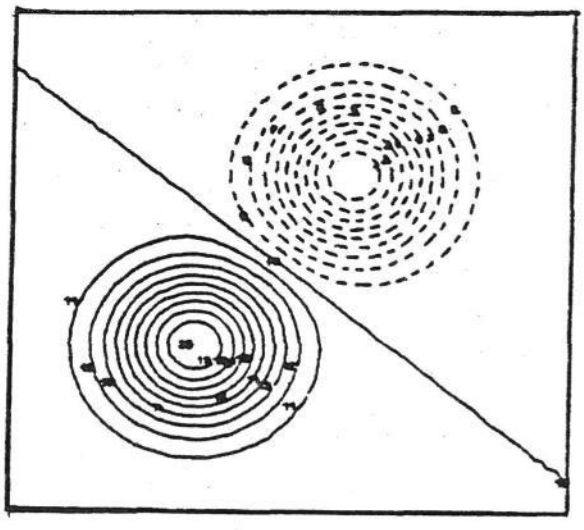
S T A R L I N K U S E R N O T E 14.1

The CONTOUR Package on VAX

15 June 1981

A FORTRAN contouring package is now available on the VAX. There are two user level routines (HIGR_CNTR2A, HIGR_CNTR2B) for the production of contour maps of a surface, for which the heights are given at the points of a mesh. HIGR_CNTR2A is used for contouring over a (possibly skewed) regular rectangular mesh , and HIGR_CNTR2B for an irregular (but still rectangular) one. Within each routine a number of options concerning the drawing are available. These allow for a choice of two methods of contouring over the grid, user specified or routine calculated heights, specification of the angle between the axes and the grid, and various options concerning the layout of the map, labelling of the contours and distinctions between the contours. However as these are available via a common block the user need only specify those options he or she requires (if any) which are different from the default set. Only those items of data which are necessary for a contour map are supplied as arguments to the routines.

This documentation is based on ATLAS GRAPHICS USER NOTE 1 ; issued 2 April 1976.



SIMPLE USE OF CONTOUR

The VAX version of CONTOUR is written above the package GKS and it is normal to use the routines HIGR_GZBGN & HIGR_GZEND to set up & close GKS for CONTOUR. It is not necessary to consult GKS documentation for simple use of CONTOUR.

HIGR_GZBGN has four arguments which are the following:

(i) Workstation identifier. An integer of the user's choice
(ii) Connection identifier. An integer which distinguishes between devices of the same type. This is usually zero but this may change in future versions of GKS.
(iii) Workstation type. An integer which takes the following values

1: ARGS
2: TEKTRONIX
3: GOC

(iv) Text precision. This takes the values 0, 1, &2. Precision 2 allows character size to be accurately calculated by the package but precisions 0 & 1 are much faster in plotting.

HIGR_GZEND has only one parameter which is the first parameter in HIGR_GZBGN

Simple maps

HIGR_CNTR2A, HIGR_CNTR2B

```
HIGR_CNTR2A(RMESH, UNUSED, ID, M, N, HEIGTS, NCONTS)
HIGR_CNTR2B(RMESH, UNUSED, XPTS, YPTS, ID, M, N, HEIGTS, NCONTS)
```

HIGR_CNTR2A is a routine for producing a contour map of a surface for which the heights are given on a regular grid (the points are assumed to be one unit apart in the x & y directions starting at (0.0, 0.0)). HIGR_CNTR2B is the routine for producing a contour map for which the heights are given on an irregular grid. It is assumed that if an irregular grid is being used then the points are closest together where most detail is needed. Hence, for both HIGR_CNTR2A and HIGR_CNTR2B, each mesh rectangle is treated by the same internal contouring routines and he X and Y coordinates are only relevant to the plotting.

The arguments of these routines are defined as follows:

RMESH is a two-dimensional REAL array of size (ID, N) which contains the heights at the grid points. These are arranged so that the first dimension increases as Y increases, and the second as X.

UNUSED is a two dimensional LOGICAL array of the same size as RMESH which is used by the routine as workspace.

XPTS, YPTS are the one dimensional REAL arrays of size N and M respectively and contain the distances of successive points along each axis so that RMESH(I, J) is taken to be at (XPTS(J), YPTS(I)). Any skewing will be about the point (OX, OY) which is by default at (0.0, 0.0) but the user may change this.

ID is the size of the first dimension of RMESH. This is necessary in case M & N are read in. (As arrays must be declared explicitly in FORTRAN this s needed for the subroutines to use the correct elements of RMESH if only part of the array is used. Usually ID = M.)

M, N are the number of points in the X & Y directions respectively.

HEIGTS is a one-dimensional REAL array of size NCONTS and contains the contour heights if they are specified or is used to store them if they are calculated (this is the default option).

NCONTS is the number of contour heights.

It is necessary for the user to set up the plotting window for these routines with the GKS routine GKS_SW(X1, Y1, X2, Y2). If there is no skewing HIGR_CNTR2A will consider the array element RMESH(I, J) to be the data value at the coordinates (J-1, I-1), HIGR_CNTR2B will consider it to be the data value at the coordinates (XPTS(J), YPTS(J)). If skewing is used the horizontal dimension of the map will increase .

FURTHER FACILITIES

Contour Key

HIGR_CNTKEY

```
HIGR_CNTKEY(X, Y, HEIGTS, N1, N2)
```

HIGR_CNTKEY is the routine for plotting a key to the contour heights (the contours are only labelled with the contour number) and is normally called after the call to HIGR_CNTR2A or HIGR_CNTR2B. The key is plotted within a rectangle (not drawn) of size 22 x character width by (N2-N1+8) x character height x 1.7. The character size is set in HIGR_CNTR2A & HIGR_CNTR2B but may be altered in the common block by the user.

The arguments of the routine are defined as follows:

X, Y are the x & y coordinates of th top left-hand corner of the exscribed rectangle described above.

HEIGTS is a one-dimensional array containing the contour heights and should be the array specified in the call to the contouring routine.

N1, N2 are the numbers of the first and last contours to be included in the key. (Several keys may be plotted to include all the contours.)

Options

COMMON/HIGR_CNTOPT/ICON, ICH, OX, OY, RCOS, IBOX, IGR, ILAB, RFR, RCH, IT, IDF, RLV

Various options concerning the production of the map are available as outlined in the introduction. These are specified by assigning values to the thirteen variables in a named COMMON block (HIGR_CNTOPT). Default values are assigned to those variables by means of a BLOCK DATA segment so that values only need be assigned to those variables corresponding to an option for which a value other than the default is required. The options and corresponding values are outlined below:

VARIABLE	OPTIONS AVAILABLE	DEFAULT VALUE
ICON	Internal contouring routines HIGR_CNTRH1 and HIGR_CNTRH2 are used when ICON = 1 & 2 respectively	2
ICH	Contour heights are specified by user (ICH=1) or by routine (ICH=0)	0
OX, OY	Offset of origin of the grid from the origin of the users coordinates	0.0, 0.0
RCOS	Cosine of the skew angle of the grid	0.0
IBOX	Frame drawn round map (IBOX=1) or not (IBOX=0)	1
IGR	Grid drawn (IGR=1) or not (IGR=0)	0
ILAB	Contours are labelled : none (ILAB=0), every Ith one (ILAB=I)	1
RFR	Frequency of labelling on contours. Labels appear every ICON*RFR*MAX(M,N) steps with a minimum of one per contour. which is acheived with RFR set to a very large value or zero.	1.0
RCH	Height of characters used in units of m/80 for HIGR_CNTR2A or (YPTS(M)-YPTS(1))/80 for HIGR_CNTR2B	1.0
IT	Contours drawn brighter: values as ILAB	0
IDF	Differentiate between contours above and below a certain level; those below drawn as broken lines (IDF=1) or no differentiation (IDF=0).	0
RLV	The level associated with IDF	0.0

NOTES ON USE

1. The routines HIGR_CNTR2A & HIGR_CNTR2B do not set up a coordinate system. This should be done by the GKS subroutine GKS_SW(X1,Y1,X2,Y2) where (X1,Y1) & (X2,Y2) are the coordinates of the bottom left and top right extremities of the plotting area in world (i.e. user) coordinates.

2. The package uses the following names which should be avoided by the user:

Routine names:

HIGR_CNTR2A, HIGR_CNTR2B, HIGR_CNTKEY, HIGR_CNTDAT, HIGR_CNTCHK, HIGR_CNTHTS
HIGR_CNTRH1, HIGR_CNTRH2, HIGR_CNTGRD, HIGR_CNTDRW

COMMON block names:

HIGR_CNTOPT, HIGR_CNTINT

3. Internal contouring routines

HIGR_CNTRH1, HIGR_CNTRH2

These routines are not callable by the user but are described here briefly to enable him or her to choose which is required. In both routines the basic method is to take each contour height in turn and trace any contours of this height through the mesh. In HIGR_CNTRH1 inverse linear interpolation is used to find the points where the contour crosses the mesh lines and these points are joined by straight lines. Any ambiguity as to which way a contour turns is solved by assuming 'high ground on the right'. In HIGR_CNTRH2 the surface height at the centre of each square is approximated by the average height at each of the four corners. The grid is now considered to be triangular and no ambiguity ca occur when the inverse linear interpolation method is applied. The advantage of HIGR_CNTRH1 is that it is faster.

4. Use of GKS with high level routines.

See SUN/13.1: "USE OF GKS WITH HIGH LEVEL ROUTINES"

CONTOUR drawing styles

CONTOUR will, by default, distinguish certain aspects of a picture, if the facilities (chiefly colour) are available on a device. There are twelve numbered CONTOUR pens corresponding to the various features of a CONTOUR map as follows:

1: Frame outline.
2: Major contours above sea-level
3: Major contours below sea-level
4: Minor contours above sea-level
5: Data point grid
6: Minor contours below sea-level
7: Spare
8: Spare
9: Contour labels & contour key title
10: Contour height values on key
11: Contour key subtitles
12: Spare

The CONTOUR pens are mapped onto a series of highlights which are set up by HIGR_GZBGN with a standard set of styles & colours. The pens are related to the highlights as follows:

CONTOUR PEN	HIGHLIGHT
1	1
2	2
3	4
4	8
5	5
6	10
7	1
8	1
9	1
10	6
11	7
12	8

The highlights, which can be the same from one high level package to another, are defined by default as follows:

Highlight	Definition
1	White or black (whichever contrasts background)
2	Red
3	Green
4	Blue
5	Cyan
6	Magenta
7	Yellow
8	Pink
9	Pale green
10	Pale blue
20	Dashed (linedrawing only). Colour as highlight 1.

Highlights 8, 9, &10 are suitable for minor parts of the picture such as the graticule.

The user can select different highlights for different aspects of the graph by calling HIGR_CNTPEN(HILITE, CP) which causes the highlight number HILITE to be assigned to the CONTOUR pen CP for subsequent drawing.

If totally different colours or styles are required, GKS or GKS-related routines must be used. These are covered under "USE OF GKS WITH HIGH LEVEL ROUTINES" in SUN/13.1.

CONTOUR USER ROUTINES

HIGR_CNTR2A

Draws contour map for regular grid.

Format of call:

```
CALL HIGR_CNTR2A(RMESH, UNUSED, ID, M, N, HEIGTS, NCONTS)
```

List of arguments:

1: RMESH	R	array of size (ID, N)
2: UNUSED	L	array of size (ID, N)
3: ID	I	
4: M	I	
5: N	I	
6: HEIGTS	R	array of size NCONTS
7: NCONTS	I	

RMESH is a two-dimensional REAL array of size (ID, N) which contains th heights at the grid points. These are arranged so that the first dimension increases as Y increases, and the second as X.
UNUSED is a two dimensional logical array of the same size as RMESH which is used by the routine as workspace.
ID is the size of the first dimension of RMESH. This is necessary in c M & N are read in. (As arrays must be declared explicitly in FORTRAN this is needed for the subroutines to use the correct elements of RMES if only part of the array is used. Usually ID = M.)
M, N are the number of points in the X & Y directions respectively.
HEIGTS is a one-dimensional REAL array of size NCONTS and contains the contour heights if they are specified or is used to store them if they are calculated (this is the default option).
NCONTS is the number of contour heights.

HIGR_CNTR2B

Draws a contour map for an irregular grid.

Format of call:

```
CALL HIGR_CNTR2B(RMESH, UNUSED, XPTS, YPTS, ID, M, N, HEIGTS, NCONTS)
```

List of arguments:

1: RMESH	R	array of size (ID, N)
2: UNUSED	L	array of size (ID, N)
3: XPTS	R	array of size N
4: YPTS	R	array of size M
5: ID	I	
6: M	I	
7: N	I	
8: HEIGHTS	R	array of size NCONTS
9: NCONTS	I	

XPTS & YPTS are arrays of dimension N & M respectively and contain the distances of succesive points along each axis from (OX, OY). All the other arguments are as in HIGR_CNTR2A

HIGR CNTKEY

This draws the contour key.

Format of call:

```
CALL HIGR_CNTKEY(X, Y, HEIGTS, N1, N2)
```

List of arguments:

1: X	R	
2: Y	R	
3: HEIGTS	R	array as in HIGR_CNTR2A & HIGR_CNTR2B
4: N1	I	
5: N2	I	

(X, Y) is the top left hand corner of the key.
HEIGTS is the array containing the contour heights.
N1 & N2 are the lowest and highest contour numbers to be included in the key.

HIGR CNTPEN

This assigns a highlight to a CONTOUR pen.

Format of call:

```
CALL HIGR_CNTPEN(N, NPEN)
```

List of arguments:

1: N	I
2: NPEN	I

N is the highlight number & NPEN the pen number.

EXTRA USER ROUTINES

HIGR GZBGN

starts up GKS workstation and set text & pen representations.

Format of call:

```
CALL HIGR_GZBGN(WKID, CONID, WS, PRECIS)
```

List of arguments:

```
1: WKID        I
2: CONID       I
3: WS          I
4: PRECIS      I
```

WKID is the workstation identifier.
CONID is the connection identifier.
WS is the workstation type.
PRECIS is the text precision.
See "SIMPLE USE OF CONTOUR"

HIGR GZEND

Closes down active GKS workstation and shuts down GKS

Format of call:

```
CALL HIGR_GZEND(WKID)
```

List of arguments:

```
1: WKID        I
```

WKID is the workstation identifier.

******SEE SUN/13.1 FOR MORE******

LINKING AND EXECUTING

To link the program PROG on the VAX use the following command:

```
LINK PROG,HIGRLINK/OPT
```

Before executing a program the following assignment must be made:

```
ASSIGN GKSWDT FOR030
```

The common block HIGR_CNTOPT may be accessed as follows in a program:

```
INCLUDE 'HIGRCNTOPT'
```

*** SOME ILLUSTRATIONS & SOME SAMPLE PROGRAMS FOLLOW ***

Sample Programs

```
      PROGRAM CTEST1
* TEST OF CNTR2A WITH DEFAULT OPTIONS
      LOGICAL UNUSED(50,50)
      REAL RMESH(50,50),HEIGHTS(10)
* SET UP COORDINATE SYSTEM
      CALL HIGR_GZBGN(4,0,2,2)
      CALL GKS_SW(0.0,0.0,49.0,49.0)
      CALL GKS_SVW(0.01,0.01,0.99,0.99)
* WORK OUT DATA
      DO J=1,50
        Y=0.14*J-0.1
        DO K=1,50
          X=0.14*K-0.1
          Z1=8.0*EXP(-((X-2.3)*(X-2.3)+(Y-2.3)*(Y-2.3)))
          Z2=8.0*EXP(-((X-4.2)*(X-4.2)+(Y-4.6)*(Y-4.6)))
          RMESH(J,K)=Z1+Z2
        END DO
      END DO
* DRAW CONTOUR AND PLOT KEY.
      CALL HIGR_CNTR2A(RMESH,UNUSED,50,50,50,HEIGTS,8)
      CALL HIGR_CNTKEY(0.0,49.0,HEIGTS,1,8)
* END PROGRAM
      CALL HIGR_GZEND(4)
      END
```

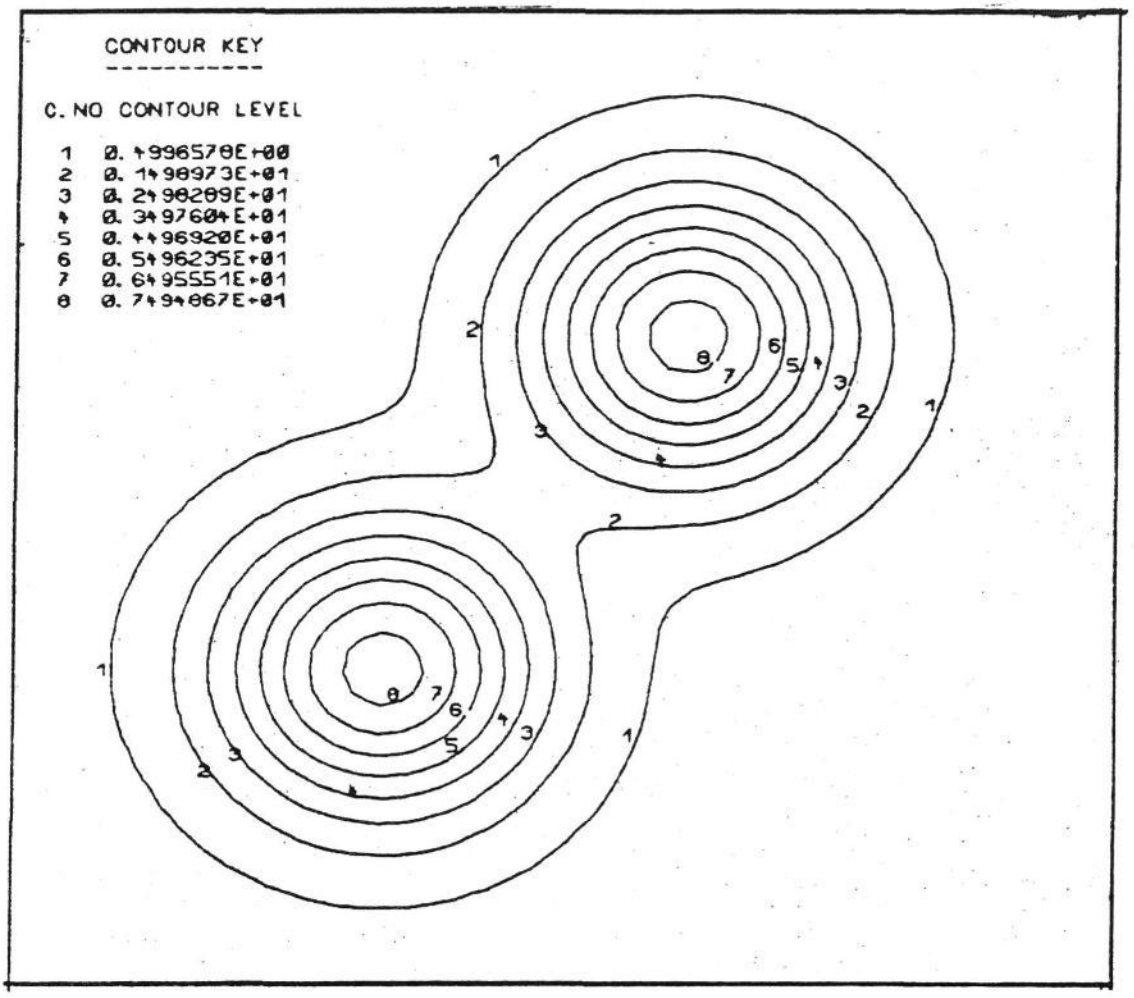
This produced figure 1

```
      PROGRAM CTEST2
* TEST OF CNTR2B
      LOGICAL UNUSED(52,50)
      REAL RMESH(52,50),HEIGTS(8),XPTS(50),YPTS(52)
      INCLUDE 'HIGRCNTOPT'
* SET COORDINATES OF DATA POINTS AND CONTOUR HEIGHTS.
      DATA HEIGTS/0.5,1.5,2.5,3.5,4.5,5.5,6.5,7.5/
      DATA XPTS/0.0,0.4,0.7,0.9,1.1,1.3,1.5,1.6,1.7,1.8,1.9,2.0,2.1,2.2,
     1          2.3,2.4,2.5,2.6,2.7,2.8,2.9,3.0,3.1,3.2,3.3,3.4,3.5,3.6,
     2          3.7,3.8,3.9,4.0,4.1,4.2,4.3,4.4,4.5,4.6,4.7,4.8,4.9,5.0,
     3          5.2,5.4,5.6,5.8,6.0,6.2,6.5,6.9/
      DATA YPTS/0.0,0.4,0.7,0.9,1.1,1.3,1.5,1.6,1.7,1.8,1.9,2.0,2.1,2.2,
     1          2.3,2.4,2.5,2.6,2.7,2.8,2.9,3.0,3.1,3.2,3.3,3.4,3.5,3.6,
     2          3.7,3.8,3.9,4.0,4.1,4.2,4.3,4.4,4.5,4.6,4.7,4.8,4.9,5.0,
     3          5.1,5.2,5.3,5.4,5.6,5.8,6.0,6.2,6.5,6.9/
* STARTUP GKS
      CALL HIGR_GZBGN(4,0,2,2)
* SET UP SCREEN LIMITS
      CALL GKS_SW(0.0,0.0,9.2,6.9)
* VIEWPORT TO PRESERVE PERSPECTIVE.
      CALL GKS_SVW(0.0,0.125,1.0,0.875)
      DO J=1,52
        Y=YPTS(J)
        DO K=1,50
          X=XPTS(K)
          Z1=8.0*EXP(-((X-2.3)*(X-2.3)+(Y-2.3)*(Y-2.3)))
          Z2=8.0*EXP(-((X-4.2)*(X-4.2)+(Y-4.6)*(Y-4.6)))
          RMESH(J,K)=Z1+Z2
        END DO
      END DO
* SET OPTIONS
      ICH=1
      RCOS=0.3333
      IGR=1
      IT=2
      IDF=1
      RLV=4.0
      CALL HIGR_CNTR2B(RMESH,UNUSED,XPTS,YPTS,52,52,50,HEIGTS,8)
      CALL HIGR_CNTKEY(0.0,7.0,HEIGTS,1,8)
      CALL HIGR_GZEND(4)
      END
```

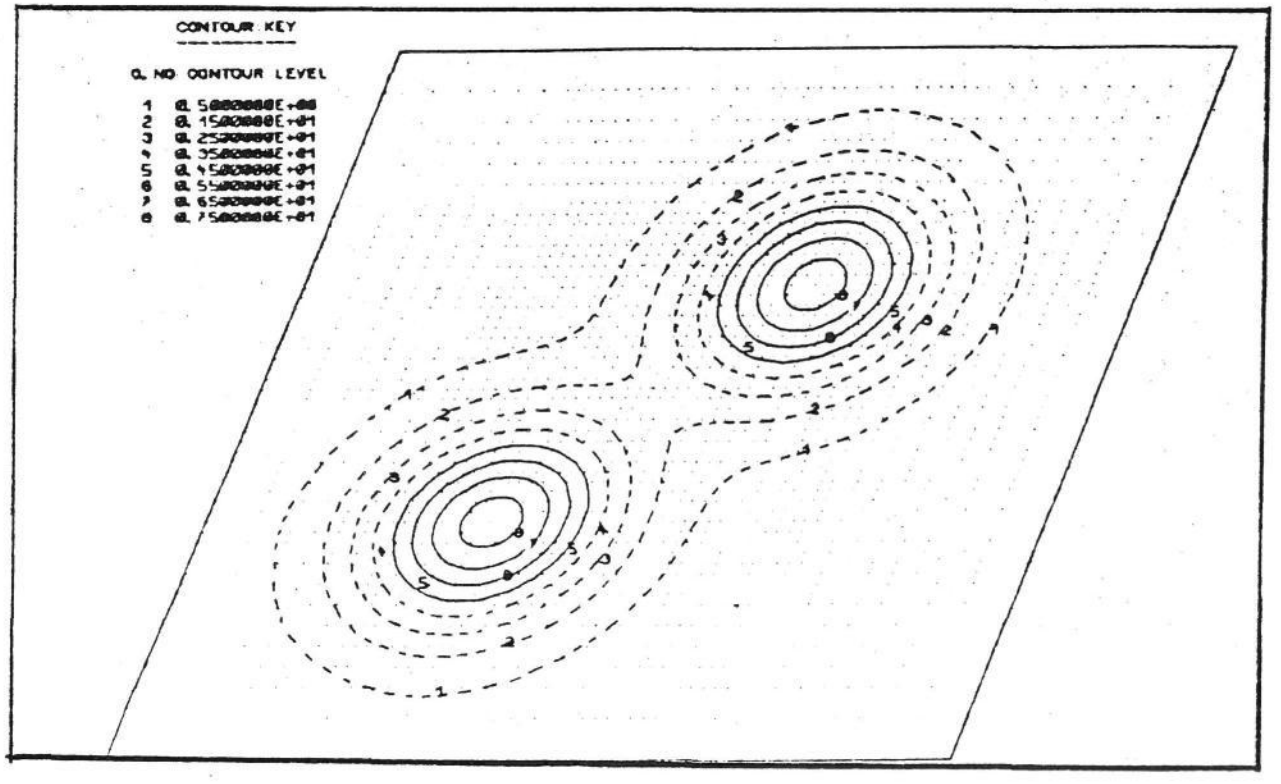
This produced figure 2

J. M. R. Martin

1


CONTOUR KEY
C. NO CONTOUR LEVEL
1 0.1996570E+00
2 0.1498973E+01
3 0.2498209E+01
4 0.3497604E+01
5 0.4496920E+01
6 0.5496235E+01
7 0.6495551E+01
8 0.7494867E+01

2


CONTOUR KEY
C. NO CONTOUR LEVEL