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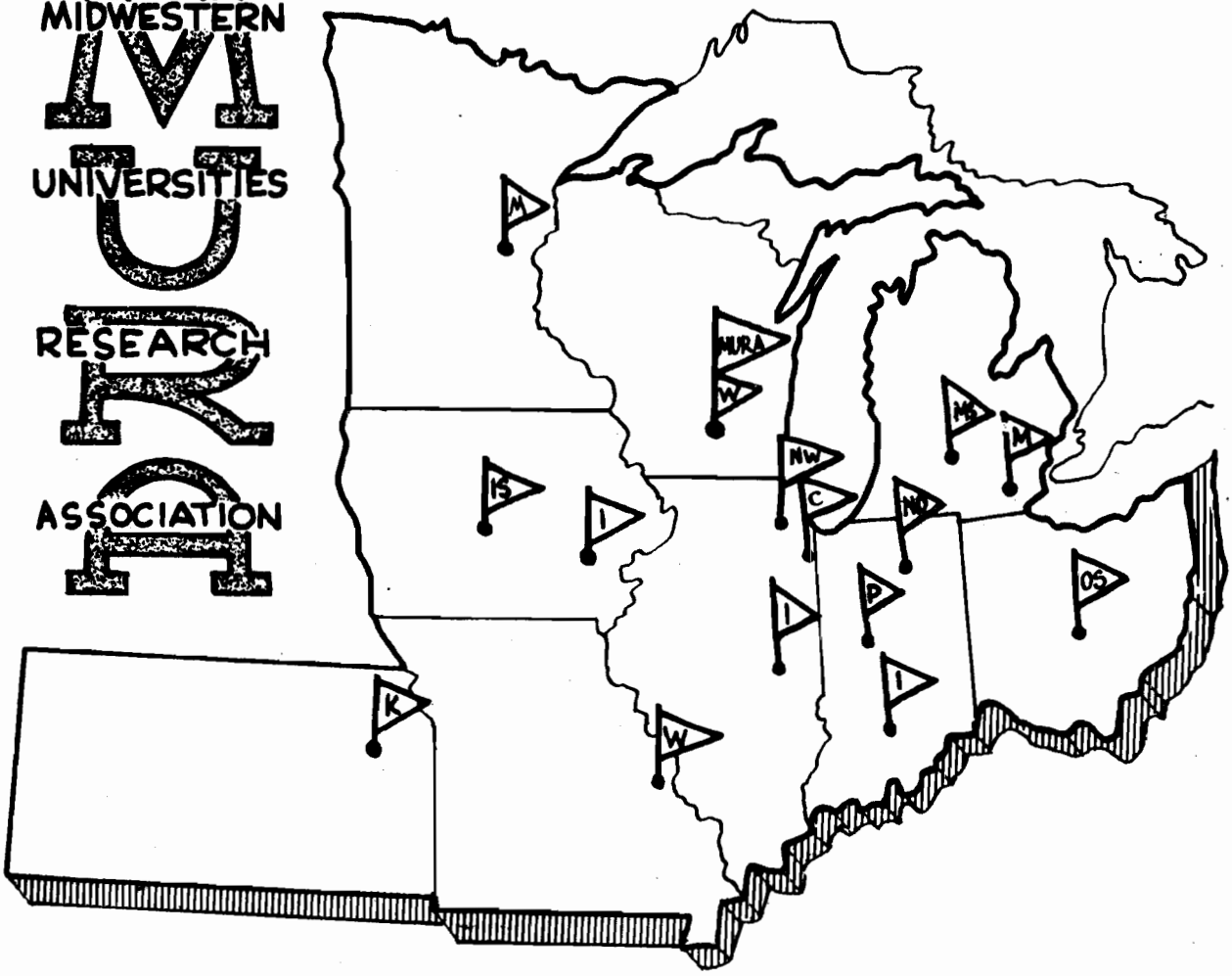

THE PARMESH DYNAMICS PROGRAM-III

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The PARMESH Dynamics Program-III

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March 1, 1962

ABSTRACT

This report is a continuation of reports MURA-629, 630, and describes various different field inputs available in the PARMESH program.

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This report is a continuation of reports MURA-629, 630, and describes the various different field inputs available with the PARMESH program.

In MURA-629, one particular field input was described where the harmonics of the median plane magnetic field are given as a function of r by a table of values at equal r-intervals. We will indicate this particular input field by B_y.

I. Analytic Harmonics Input, $\overline{B}_y$

For this input, the median plane magnetic field is given by

$$\overline{B}_y = \overline{\lambda}(A + X)^{\overline{k}} \left\{ b_o + \sum_{n=1}^{\overline{NMX}} b_n \cos \left[M_n \left(\theta - \frac{1}{\overline{w}} \ln (A + X) \right) - \alpha_n \right] \right\} \tag{1.1}$$

The parameter $\overline{\lambda}$ is used also as an indicator $\overline{\lambda} \neq 0$ indicates that this field input is being used. Up to thirty harmonics are permitted. The addresses of the various parameters are given on an agenda sheet at the end of this report. (See agenda sheet 3.)

One may use the harmonics-mesh input B_y, and the analytic harmonic input $\overline{B}_y$ simultaneously and form the field

$$\text{Median Plane Field} = B_y + \overline{B}_y. \tag{1.2}$$

II. Analytic Harmonic Input, ϕ

In addition to the analytic median plane field $\overline{B}_y$, a second analytic field ϕ is available which is given by

in the θ-direction.

A second way to put in the measured field values is to use the measured field directly in the dynamics program. This field input is called B_{y_d}. It has the advantage of saving the computing time necessary to compute all the Fourier coefficients. In order to interpolate to find the field at θ-points which do not lie in the measurement mesh, B_{y_d} is computed from

$$B_{y_d}(\theta) = \sum_k B_{y_d}(\theta_k)\, G(\theta - \theta_k) , \tag{3.1}$$

where $B_{y_d}(\theta_k)$ is the measured field at points on the measurement mesh and $G(\theta - \theta_k)$ is given by

$$G(\theta) = \frac{1}{\bar{M}} \frac{\sin\left[(\bar{M} + \tfrac{1}{2})\,\bar{N}\,\theta\right]}{\sin(\bar{N}\theta/2)} , \tag{3.2}$$

where M is the total number of points at which the field is measured in the θ-direction, $2\pi/\bar{N}$ is the period of the field $B_{y_d}(\theta)$. The use of this Green's function, $G(\theta)$, is exactly equivalent to interpolating by Fourier analyzing and using up to the $\bar{M}$ harmonics to compute $B_{y_d}(\theta)$. The equivalence between the Fourier analysis and using this Green's function $G(\theta)$ can be shown using the following representation of $G(\theta)$

$$G(\theta) = \frac{1}{\bar{M}} \sum_{n=-\bar{M}}^{\bar{M}} e^{in\bar{N}\theta} . \tag{3.3}$$

We now describe the input parameters which must be supplied by the user to use the $B_{y_d}(\theta)$ field input (see the agenda sheet at end of report labeled Direct Mesh; where the

addresses are given).

PARAMETER	MEANING OF PARAMETER
NPNT	NPNT is equivalent to M in Eq. (3.2) and is the total number of points at which the field was measured in the θ-direction. NPNT is used as an indicator by the program. NPNT $\neq 0$ indicates that this input is being used.
NDMX	NDMX is equivalent to $\overline{M}$ of Eq. (3.2). It is internally put equal to (NPNT-1)/2 or the closest integer below this.
Z	The period of the field $B_{y_d} = 2\pi/\overline{N}$ where $\overline{N} = Z \times N$ and N is the true period of the median plane field. Ordinarily Z = 1, and $\overline{N} = N$, but in some cases it is convenient to have the period of $B_{y_d}(\theta)$ different from $2\pi/N$. Z is internally set equal to one.
NSPD	NSPD is the number of points $B_{y_d}(\theta)$ is to be found by interpolation for each experimentally measured point. For example, if the measured mesh points are three integration steps apart, then NSPD = 6.
NOD	NOD specifies the initial θ of the measured field mesh B_{y_d} relative to the initial θ of the Parmesh dynamics mesh in units of the Parmesh mesh interval which is 1/(2 x NRK)

R1 — R1D is the initial radius of the measured field mesh B_{y_d}.

DRD — DRD is the mesh interval in the r-direction of the field mesh B_{y_d}.

LRD — LRD is the number of mesh points in the r-direction of the field mesh B_{y_d}. LRD $\leq$ 120.

LTHD — The field mesh B_{y_d} is assumed to be broken up into blocks in the θ-direction, the interval in the θ-direction being NSPD in units of the Parmesh field mesh interval. LTHD $\leq$ 30.

DTI — DTI is used as indicator (Data Tape Indicator). DTI indicates to the program that this input is being used and that the mesh B_{y_d} is to be read off tape. In terms of the three Data sections mentioned in MURA-629, DTI should appear in the DATA #1 section before the first END DATA card.

HMI — This indicator should be put different from zero if the harmonic inputs, B_y and $\overline{B}_y$ are not being used.

One may also note that if the mesh B_{y_d} is read off tape then the parameters R1, DRD, LRD, LTHD, are also read off the tape.

The mesh B_{y_d} is read from a tape called the DATAM TAPE which is assumed to have the following structure.

DATAM TAPE Structure

Record 1. This record contains the numbers DTID, LTHD, LRD, R1D

DRD, NBTD, in the order given. DTID is the DATAM TAPE ID, and NBTD is the total number of blocks on the tape.

Record 2. This record contains NB, the block number, followed by the field mesh B_{y_d} in this block. The order in which B_{y_d} is written is such that we first find LRD works which is the field in the first θ-plane, from r = R1D to r = R1D + (LRD - 1)DRD, followed by a second LRD words which is the field in the second θ-planes and so on up to LTHD θ-planes.

Record 3 up to record NBTD +1 are similar to record 2 with the block number going from NB = 2 to NB = NBTD.

The DATAM TAPE should be on Tape Drive #6. The parameters NB1D and NB2D (see agendum sheet) give the first and last block read off the DATAM TAPE.

One may use the B_{y_d} field simultaneously with the B_y, $\overline{B}_y$, and ϕ inputs and thus form the median plane field.

$$\text{Median plane field} = (B_y + \overline{B}_y + B_{y_d})\ \phi \ .$$

IV. S (θ) Input

This input allows one to enter a median plane magnetic field which depends only on θ and which is specified by a linear mesh in θ, that is a table of the values of $S(\theta)$ at equally spaced intervals. The program will interpolate values of $S(\theta)$ in between the value given using the same interpolation procedure as in the case of the B_{y_d} input.

The input parameters are as follows.

NPNT — This has the same meaning as for $B_{y_d}(\theta)$ and is the total number of points at which $S(\theta)$ is given.

NPNT is again used as an indicator and NPNT $\neq 0$ indicates that the interpolation field B_{y_d} or $S(\theta)$ is to be calculated.

NDMX,Z Same meaning as for $B_{y_d}(\theta)$.

SI This is an indicator. SI $\neq 0$ indicates to the program that $S(\theta)$ and not $B_{y_d}(\theta)$ is the input being used with this interpolation method.

S(J) These are the values of $S(\theta)$ given $.1 \leq J \leq 30$.

LTHD This now has the meaning of being the large value of J for which S(J) is not zero. LTHD ≤ 30.

One may use $S(\theta)$ together with the B_y, $\overline{B}_y$, ϕ input to form the field.

$$\text{Median plane field} = (B_y + \overline{B}_y + S(\theta)) \cdot \phi \quad .$$

V. Agenda Sheets

The following agenda sheets show the addresses for the parameters required by the previously described inputs. These agenda are used, when required, in addition to those given in MURA-630 which are given again here.

In MURA-629, the input data is divided up in three sections which are divided by two END DATA cards. All the parameters for the inputs described in this report belong in the second section DATA #2, after the first END DATA card.

The symbol (T) after a parameter indicates that it is read off tape and need not be supplied unless one desires to change its value.

One may note that agenda sheets 1, 2, and 6 have a few changes or additions from what was given in MURA-630. On agenda sheet #6 $(N\theta/2\pi)_{mesh}$ is the beginning angle of the Parmesh field mesh which is different from $(N\theta/2\pi)_o$ which is the beginning angle of the dynamics run.

MURA-PARMESH

PROGRAM NO. F-40 SUBMITTER_____

Enter sense switch settings: ____ ____ ____ ____ ____ ____

1. Decimal points may be omitted only if understood to follow the rightmost digit.
2. Addresses may not contain more than 4 digits.
3. Factors may not contain more than 8 digits.
4. Exponents may not contain more than 2 digits.
5. Exponents may be omitted if zero. If not, they must be signed.
6. Values of parameters set internally are indicated in parenthesis.

Parameter	Address	Value	Parameter	Address	Value
ID	1		Mesh Description		
FEN	3600				
Information for Tape Input			x_1	26	
			Δx	27	
	20		LTH	16	
RDY1	29		L	28	
L	28		$(N\theta/2\pi)_0$	6	
DTI	3626		A (1)	21	
			N	24	
			NRK	15	
		END DATA			

MURA-PARMESH

PROGRAM NO. F-40 SUBMITTER_____

Enter sense switch settings: ____ ____ ____ ____ ____ ____

1. Decimal points may be omitted only if understood to follow the rightmost digit.
2. Addresses may not contain more than 4 digits.
3. Factors may not contain more than 8 digits.
4. Exponents may not contain more than 2 digits.
5. Exponents may be omitted if zero. If not, they must be signed.
6. Values of parameters set internally are indicated in parenthesis.

Parameter	Address	Value	Parameter	Address	Value
Harmonics-Mesh Field					
Λ	20				
k	22				
1/w	23				
S	3601				
NMX	25				
C_0 (I)	30→64				
C_1 (I)	65→69				
↓	↓				
C_{50} (I)	1780→1814				
β_1 (I)	1815→1849				
β_2 (I)	1850→1884				
↓	↓				
β_{50} (I)	3565→3599				

MURA-PARMESH

PROGRAM NO. F-40 SUBMITTER_____

Enter sense switch settings: ____ ____ ____ ____ ____ ____

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2. Addresses may not contain more than 4 digits.
3. Factors may not contain more than 8 digits.
4. Exponents may not contain more than 2 digits.
5. Exponents may be omitted if zero. If not, they must be signed.
6. Values of parameters set internally are indicated in parenthesis.

Parameter	Address	Value	Parameter	Address	Value
Analytic Harmonics Field, $\bar{B}_y$			α_3	3753	
			α_n	3751→3800	
$\bar{\lambda}$	3646				
$\overline{NMX}$	3647				
$\bar{K}$	3648				
$1/\bar{W}$	3649				
b_0	3650				
b_1	3651				
b_2	3652				
b_3	3653				
b_n	3651→3700				
M_1	3701				
M_2	3702				
M_3	3703				
M_n	3701→3750				
α_1	3751				
α_2	3752				

MURA-PARMESH

PROGRAM NO. F-40 SUBMITTER_____

Enter sense switch settings: _____ _____ _____ _____ _____ _____

1. Decimal points may be omitted only if understood to follow the rightmost digit.
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3. Factors may not contain more than 8 digits.
4. Exponents may not contain more than 2 digits.
5. Exponents may be omitted if zero. If not, they must be signed.
6. Values of parameters set internally are indicated in parenthesis.

Parameter	Address	Value	Parameter	Address	Value
Analytic Harmonics Field, ϕ			γ_2	3912	
			γ_3	3913	
PFI	3624		γ_n	3911→3940	
λ_t	3849				
NMXT	3848				
K_t	3847				
$1/W_t$	3843				
d_0	3850				
d_1	3851				
d_2	3852				
d_3	3853				
d_n	3851→3880				
ω_1	3881				
ω_2	3882				
ω_3	3883				
ω_n	3881→3910				
γ_1	3911				

MURA/FORTRAN-PARMESH

PROGRAM NO. F-40 SUBMITTER _____

Enter sense switch settings: ____ ____ ____ ____ ____ ____

1. Decimal points may be omitted only if understood to follow the rightmost digit.
2. Addresses may not contain more than 4 digits.
3. Factors may not contain more than 8 digits.
4. Exponents may not contain more than 2 digits.
5. Exponents may be omitted if zero. If not, they must be signed.
6. Values of parameters set internally are indicated in parenthesis.

Parameter	Address	Value	Parameter	Address	Value
Direct Mesh			SI	3627	
NPNT	3614		NPNT	3614	
NDMX (*)	3628		NDMX (*)	3628	
Z (1)	3629		Z (1)	3629	
NSPD	3617		LTHD	3623	
NOD	3616		S (J)	10101→10130	
NB1D	3618				
NB2D	3619				
R1D (T)	3620				
DRD (T)	3621				
LRD (T)	3622				
LTHD (T)	3623				
HMI	3615				

*→(NPNT-1)/2

MURA-PARMESH

PROGRAM NO. F-40 SUBMITTER_____

Enter sense switch settings: ____ ____ ____ ____ ____ ____

1. Decimal points may be omitted only if understood to follow the rightmost digit.
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3. Factors may not contain more than 8 digits.
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Parameter	Address	Value	Parameter	Address	Value
Dynamics Data			λ	20	
		END DATA	HD	17	
ID	1		$(N\theta/2\pi)$mesh	3609	
X	2				
PX	3				
Y	4				
PY	5				
$(N\theta/2\pi)o$	6				
NP	12				
NE	13				
MEQ (2)	14				
ε_{test}	18				
ε_{tune}	19				
XMAX (5)	7				
PXMAX(.999)	8				
YMAX (.5)	9				
MAX(.999)	10				
					END DATA