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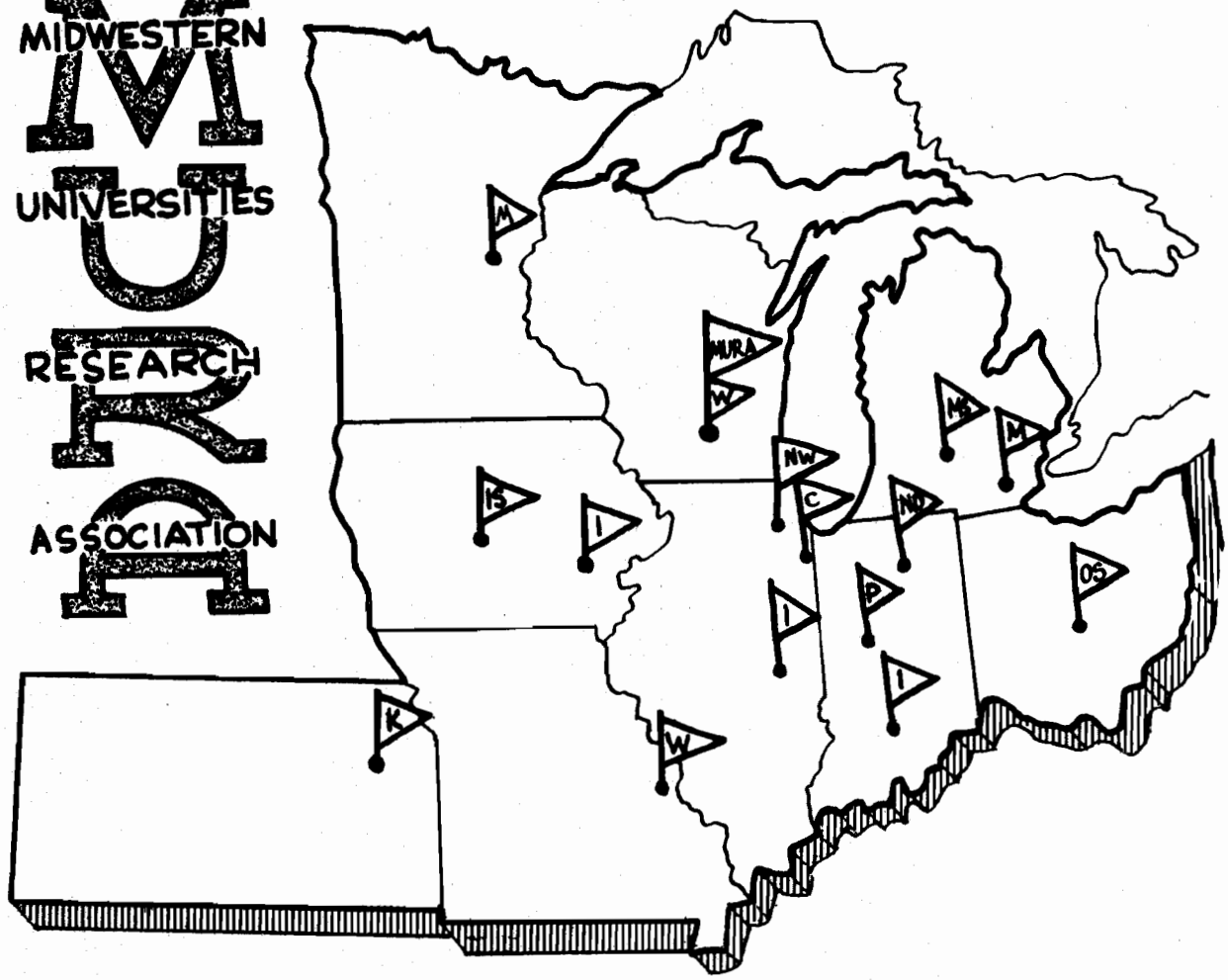

THE PARMESH DYNAMICS PROGRAM

Jess Anderson and George Parzen

REPORT **NUMBER** 630

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THE PARMESH DYNAMICS PROGRAM

Jess Anderson and George Parzen**

December 6, 1961

ABSTRACT

This report is a continuation of the report MURA-629 on the PARMESH dynamics program, and presents the part of PARMESH which calculates the linear orbit properties such as the equilibrium orbit and betatron oscillation frequencies.

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**On leave from the University of Notre Dame, Notre Dame, Indiana.

This report is a continuation of MURA-629 and presents the part of the PARMESH which calculates the linear orbit properties such as the equilibrium orbit and betatron oscillation frequencies.

The method presented here for finding the equilibrium orbit and tunes seems slower and less accurate than the methods proposed by Gordon and Welton,[1] and this part of the program will probably be changed in the future. However, the method used here does seem adequate for most purposes.

The program uses the quantity ε_{test} as an indicater which tells the program whether the run is a tune calulation or an ordinary dynamics run. ε_{test} not zero indicates a tune calculation; ε_{test} zero indicates a dynamics run.

I. Equilibrium Orbit Calculation.

To find the fixed point, the point on the equilibrium orbit at $\theta = \theta_0$ the initial angle, a run is done starting with the entered initial conditions x_0, p_{x_0}, y_0, p_{y_0}, and covering three periods in θ. The fixed point x_f is then calculated by the equations

$$\cos\sigma = \frac{1}{2} \frac{x_3 + x_1 - x_2 - x_0,}{x_2 - x_1}$$

$$x_f = x_1 + \frac{1}{2\,(1-\cos\sigma)} (x_2 + x_0 - {}^2x_1)$$

where x_1, x_2, x_3 are the values of x at the end of the first, second and third periods respectively.

p_{x_f} is found from a similar formula

$$p_{x_f} = p_{x_1} + \frac{1}{2\,(1-\cos\sigma)}\,(p_{x_2} + p_{x_0} - 2p_{x_1})\ .$$

The desired accuracy in x_f is given by ε_{test}. If $|x_f - x_0| > \varepsilon_{test}$, then another three period run is done starting with the above calculated x_f, p_{x_f} as initial conditions and a new fixed point is found which is again compared with the starting value. This is repeated until the accuracy given by ε_{test} is attained. A maximum of ten trials is permitted.

Once the fixed point is found, the entire equilibrium is found by a one period run starting at the fixed point.

II. Tune Calculation.

After finding the fixed point, a three period run is done to find the radial betatron oscillation frequency, ν_r. The run is started with initial conditions

$$x_0 = x_f + \varepsilon_{tune}$$

$$p_{x_0} = p_{x_f}$$

$$y_0 = 0$$

$$p_{y_0} = 0$$

where ε_{tune} gives the amplitude of the betatron oscillation. The radial tune is then found from

$$\cos\sigma = \frac{1}{2}\,\frac{x_3 + x_1 - x_2 - x_0}{x_2 - x_1}\ .$$

The program prints out for the tune $N\sigma/2\pi$, where $2\pi/N$ is the period. One may note however, that since σ is not uniquely determined by the above formula, the actual tune can differ from

$N\sigma/2\pi$ by a multiple of N.

After computing the radial tune, a three-period run is done to find the vertical tune; ν_z. This run is started with initial conditions

$$x_0 = x_f$$

$$p_{x_0} = p_f$$

$$y_0 = \varepsilon_{tune}$$

$$p_{y_0} = 0 \quad .$$

III. Data Input.

The following three data sheets exhibit the input parameter and their addresses for the field input described in MURA-629 and for doing either dynamics or tune runs.

References

1. M. Gordon and T. Welton; ORNL-2765

MURA-PARMESH

PROGRAM NO. F-40 SUMITTER

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	
Δ	20		LTH	16	
RDY1	29		L	28	
L	28		$(N\theta/2\pi)_b$	6	
			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
DYNAMICS DATA			λ	20	
			HD	17	
ID	1				
X	2				
PX	3				
Y	4				
PY	5				
$(N\phi/2\pi)_o$	6				
NP	12				
NE	13				
MEQ (2)	14				
ε_{test}	18				
ε_{tune}	19				
XMAX(5)	7				
PXMAX (.999)	8				
YMAX (.5)	9				
PYMAX (.999)	10				
					END DATA