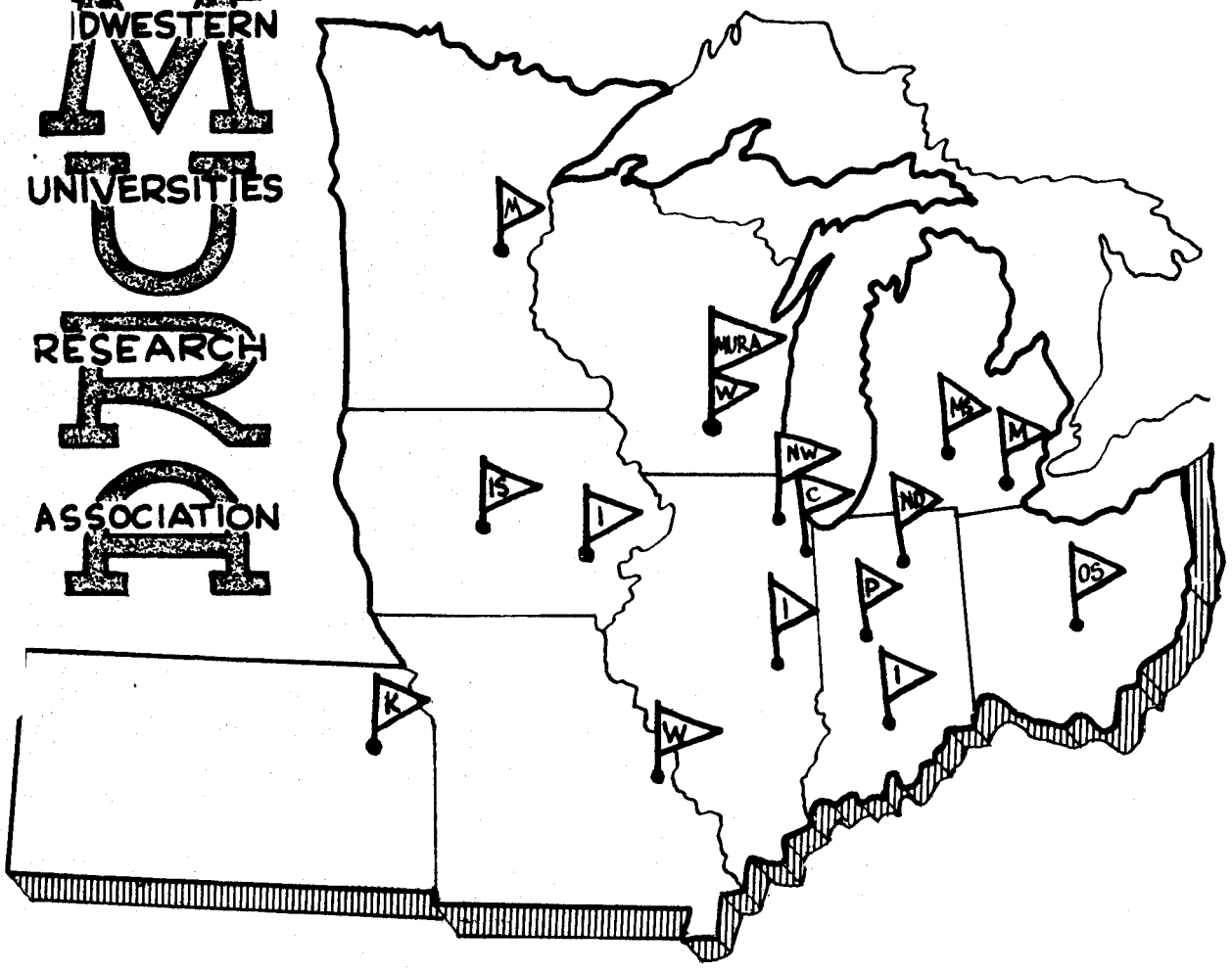
~~ZGS LIBRARY~~ MURA 233
H-1

Fermilab Library
0 1160 0038620 5

MIDWESTERN UNIVERSITIES RESEARCH ASSOCIATION



REPORT ALGYTEE
(Program 58)
March, 1957

NUMBER 233
Internal
(IBM Program)

MURA-233

MEMORANDUM

To: Users of Algytee July 29, 1957

From: M. R. Storm

Subject: Algytee Bumps

This memorandum should be attached to the Algytee Bumps write-up and become a permanent part of it. Contrary to an earlier statement, the Bump will be applied after all transformations have been applied a prescribed number of times, N_b, corresponding to the number of sectors in the machine. After each n_i shown on the original Algytee agendum a check will be made within the calculator for the special signal -0. When it is encountered, an accurate count will be kept to compare with N_b for purposes of determining whether to apply the Bump. N_b is an integer which should be entered on the Bump agendum sheet in location 4032.

Algytee Bumps

Another transformation type for the Algytee program (#58) has been provided. This transformation is called a bump and is of the following form:

$$x_{n+1} = x_n + a,$$
$$P_{x_{n+1}} = P_{x_n} + b,$$
$$y_{n+1} = y_n + c,$$
$$P_{y_{n+1}} = P_{y_n} + d,$$

where a, b, c, d are constants to be specified in the agenda. These constants are added to the four variables after each of the non-linear algebraic transformations T_i, have been applied their appropriate number of times, n_i. These n_i are indicated on the original Algytee agendum sheet.

The inclusion or omission of the bump feature is controlled by the setting of Sense Switch 4 and should be marked properly.

Agendum Sheet (Algytee Bumps)

Bumps (Sense Switch 4 UP). Check if desired	

Floating point numbers

Parameter	Address	Value	
		Number	Exp
a	1449		
b	1450		
c	1451		
d	1452		

INTEGER

BUMP ID	4026	7777770058

ALGYTEE (Program 58)

M. R. Storm

This program is designed to describe the betatron oscillations by means of non-linear algebraic transformations applied to the radial and axial coordinates and momenta.[1] The general transformation T_i is assumed to be of the following form:

$$T_i \equiv \begin{cases} x' = \alpha_{i1} x + \beta_{i1} P_x + \lambda_{i1} A(\xi, \eta) \\ y' = \alpha_{i2} y + \beta_{i2} P_y + \lambda_{i2} B(\xi, \eta) \\ P_x' = \alpha_{i3} x + \beta_{i3} P_x + \lambda_{i3} A(\xi, \eta) \\ P_y' = \alpha_{i4} y + \beta_{i4} P_y + \lambda_{i4} B(\xi, \eta) \end{cases}$$

where $\alpha_{ij}, \beta_{ij}, \lambda_{ij}$ are constants to be specified for j = 1, 2, 3, 4 and i = 1, 2, 3 . . . m. The functions $A(\xi, \eta)$ and $B(\xi, \eta)$ are approximated by polynomials in ξ and η through terms of degree 3 and where the variables ξ and η are given by:

$$\xi = x + u_i P_x$$
$$\eta = y + v_i P_y,$$

where u and v are constants.

The polynomials are of the form:

$$A(\xi, \eta) = k_{i1} \xi^2 + k_{i2} \eta^2 + k_{i3} \xi\eta + k_{i4} \xi^3 + k_{i5} \eta^3 + k_{i6} \xi^2\eta + k_{i7} \xi\eta^2.$$
$$B(\xi, \eta) = k'_{i1} \xi^2 + k_{i2} \eta^2 + k_{i3} \xi\eta + k_{i4} \xi^3 + k_{i5} \eta^3 + k_{i6} \xi^2\eta + k_{i7} \xi\eta^2.$$

$T_1, T_2, T_3, \ldots, T_i, \ldots T_m$ are all transformations of the same form and differ only in their constant coefficients. The maximum m of transformations allowed by the present program is 10, but this can be modified easily if the user wishes more than that number.

Each transformation is applied n_i times where the n_i's are specified appropriately on the agenda sheets. Any of these n_i's may be left blank in which case the corresponding transformation is ignored. An n_i = -0 is a signal to the computer to repeat the entire set of transformations, hence it also acts as the proper signal to signify the end of all transformations. The user should usually make the entry immediately following his last n: a - 0. However, should this special symbol be omitted, one still may be led to the correct results since a minus zero will be permanently stored at location 4048 as a possible safeguard.

After each transformation step several tests are made to determine whether or not printing shall take place. Four parameters need to be specified in order for the program to function properly. These are

N_{po} = number of steps during which no printing is desired.
N_{pp} = number of steps during which printing shall occur every N_p steps.

---

1. The equations are set forth in a memorandum: Andrew Sessler to J. N. Snyder, March 22, 1956.

N_p = number of steps plus one between each print.
N_e = number of steps to the end of the problem.

If it is desired to print after every iteration within the N_{pp} interval, then N_p is set equal to 1.

Normally, the program will proceed sequentially with the transformations in the order in which they are read in by the computer. However, a run may be started anywhere in its cycle by specifying

i_o = the number of the transformation type.
n_o = the number of times this transformation is assumed to have been applied.

At the start of every run all input parameters are initially printed. The format is best described in the form of a table (Fig. 1) similar to the printout itself. When certain parameters have not been read by the computer they will appear as zeroes.

The printing of the variables during the course of running is distinguishable by its 5 column format (Fig. 2). The first column of only 5 character length is the iteration number and the remaining four are the quantities x, y, P_x and P_y respectively. The program operates in the floating point mode, consequently all numbers other than integers will be represented by their conventional floating point form.[2] For the print-outs these appear as a signed 8 digit decimal fraction and a signed two digit decimal exponent. The decimal point is understood to be immediately to the right of the first character. For example, 1234.5×10^{-5} will appear as 12345000-02.

In the event that a run is unstable some identifying symbols and the quantity which caused the overflow are printed before proceeding to the next problem. See Fig. 2 for a more detailed description.

Use of sense switch 6 has been incorporated into the program for the conventional Search feature. That is, if a series of runs are being performed and it is desired to know that run which remains stable through N_e steps, the computer will stop when sense switch 6 is up. The agendum should be clearly marked Search and the appropriate box checked if this technique is to be employed.

A sample agendum sheet is attached and it is hoped that the remarks listed will help to clarify the notation as well as obscure quantities not previously discussed.

---

2. For a more detailed treatise on this subject refer to MURA Report 226, L. D. Fosdick.

INPUT PARAMETERS

	line no.	column 1	column 2	column 3	column 4	column 5
I*	0	ID no.	N_o	i_o	N_{po}	N_e
I	1	N_p	N_{pp}			
I	2				n_1	n_2
I	3	n_3	n_4	n_5	n_6	n_7
I	4	n_8	n_9	n_{10}	-0	
I	5					
	0	x_o	y_o	$\widetilde{P_x}$	$\widetilde{P_y}$	x_{max}
	1	y_{max}	$P_{x\ max}$	$P_{y\ max}$		
	2		u_1	v_1	k_{11}	k_{12}
	3	k_{13}	k_{14}	k_{15}	k_{16}	k_{17}
	4	k'_{11}	k'_{12}	k'_{13}	k'_{14}	k'_{15}
	5	k'_{16}	k'_{17}	α_{11}	α_{12}	α_{13}
	6	α_{14}	β_{11}	β_{12}	β_{13}	β_{14}
	7	λ_{11}	λ_{12}	λ_{13}	λ_{14}	
	8	u_2	v_2	k_{21}	k_{22}	k_{23}
	9	k_{24}	k_{25}	k_{26}	k_{27}	k'_{21}
	10	k'_{22}	k'_{23}	k'_{24}	k'_{25}	k'_{26}
	11	k'_{27}	α_{21}	α_{22}	α_{23}	α_{24}
	12	β_{21}	β_{22}	β_{23}	β_{24}	λ_{21}
	13	λ_{22}	λ_{23}	λ_{24}		3
	14	v_3	k_{31}	k_{32}	k_{33}	k_{34}
	15	k_{35}	k_{36}	k_{37}	k'_{31}	k'_{32}
	16	k'_{33}	k'_{34}	k'_{35}	k'_{36}	k'_{37}
	17	α_{31}	α_{32}	α_{33}	α_{34}	β_{31}
	18	β_{32}	β_{33}	β_{34}	λ_{31}	λ_{32}
	19	λ_{33}	λ_{34}		u_4	v_4
	20	k_{41}	k_{42}	k_{43}	k_{44}	k_{45}
	21	k_{46}	k_{47}	k'_{41}	k'_{42}	k'_{43}
	22	k'_{44}	k'_{45}	k'_{46}	k'_{47}	α_{41}
	23**	etc.	etc.	etc.	etc.	

*I stands for integers, all others are floating-point decimal numbers.

**Only thru line 22 is printed. When more lines are necessary the program will be modified accordingly.

Fig. 1

STANDARD PRINTING

step count (mod 2^{15})	column 1	column 2	column 3	column 4
00001	x	y	P_x	P_y
00002	"	"	"	"

For unstable run:

I	0000A	0000000000B	step count
	0000A	x, y, P_x or P_y	

A = 1 or 2
1 for radial dimensions x and P_x
2 for axial dimensions y and P_y

B = 1 for x overflow
= 2 for y overflow
= 3 for P_x "
= 4 for P_y "

Fig. 2

ALGYTEE (Program 58) Agendum

Parameter	Address	Value	Remarks	
ID No.	4025			INTEGERS
n_o	4026			
i_o	4027			
N_{po}	4028		# of steps without printing	
N_e	4029		# of steps to end of problem	
N_p	4030		# of steps between each print	
N_{pp}	4031		# of steps within printing interval	
n_1	4038			
n_2	4039			
n_3	4040			
n_4	4041		number of times to do	
n_5	4042		each transformation before	
n_6	4043		proceeding to the next.	
n_7	4044			
n_8	4045			
n_9	4046			
n_{10}	4047			
n_f	4048	-0		

Floating point numbers:

Parameter	Address	Value		Remarks
		number	exp.	
x_o	4090			
y_o	4091			Initial coordinate values
P_x	4092			
P_y	4093			
x_{max}	4094			upper limits for position coordinates
y_{max}	4095			
$P_{x\ max}$	4096			upper limits for momenta
$P_{y\ max}$	4097			

Parameters for $A_i(\xi, \eta)$, $B_i(\xi, \eta)$, T_i, $\xi = x + u_i P_x$, and $\eta = y + v_i P_y$

Parameter	Address	Value number	Value exp	Parameter	Address	Value number	Value exp
u_1	4101			β_{21}	4150		
v_1	4102			β_{22}	4151		
k_{11}	4103			β_{23}	4152		
k_{12}	4104			β_{24}	4153		
k_{13}	4105			λ_{21}	4154		
k_{14}	4106			λ_{22}	4155		
k_{15}	4107			λ_{23}	4156		
k_{16}	4108			λ_{24}	4157		
k_{17}	4109			u_3	4159		
k'_{11}	4110			v_3	4160		
k'_{12}	4111			k_{31}	4161		
k'_{13}	4112			k_{32}	4162		
k'_{14}	4113			k_{33}	4163		
k'_{15}	4114			k_{34}	4164		
k'_{16}	4115			k_{35}	4165		
k'_{17}	4116			k_{36}	4166		
α_{11}	4117			k_{37}	4167		
α_{12}	4118			k'_{31}	4168		
α_{13}	4119			k'_{32}	4169		
α_{14}	4120			k'_{33}	4170		
β_{11}	4121			k'_{34}	4171		
β_{12}	4122			k'_{35}	4172		
β_{13}	4123			k'_{36}	4173		
β_{14}	4124			k'_{37}	4174		
λ_{11}	4125			α_{31}	4175		
λ_{12}	4126			α_{32}	4176		
λ_{13}	4127			α_{33}	4177		
λ_{14}	4128			α_{34}	4178		
u_2	4130			β_{31}	4179		
v_2	4131			β_{32}	4180		
k_{21}	4132			β_{33}	4181		
k_{22}	4133			β_{34}	4182		
k_{23}	4134			λ_{31}	4183		
k_{24}	4135			λ_{32}	4184		
k_{25}	4136			λ_{33}	4185		
k_{26}	4137			λ_{34}	4186		
k_{27}	4138			u_4	4188		
k'_{21}	4139			v_4	4189		
k'_{22}	4140			k_{41}	4190		
k'_{23}	4141			k_{42}	4191		
k'_{24}	4142			k_{43}	4192		
k'_{25}	4143			k_{44}	4193		
k'_{26}	4144			k_{45}	4194		
k'_{27}	4145			k_{46}	4195		
α_{21}	4146			k_{47}	4196		
α_{22}	4147			k'_{41}	4197		
α_{23}	4148			k'_{42}	4198		
α_{24}	4149			k'_{43}	4199		

Parameter	Address	Value number	Value exp	Parameter	Address	Value number	Value exp
k'_{44}	4200			β_{41}	4208		
k'_{45}	4201			β_{42}	4209		
k'_{46}	4202			β_{43}	4210		
k'_{47}	4203			β_{44}	4211		
α_{41}	4204			λ_{41}	4212		
α_{42}	4205			λ_{42}	4213		
α_{43}	4206			λ_{43}	4214		
α_{44}	4207			λ_{44}	4215		

Sense Switch - Please check

SEARCH FEATURE	SENSE SWITCH 6 UP	

NOTE:

1. A floating point number should be entered as a quantity whose decimal point has been positioned between the 1st and 2nd decimal digits. Both number and exponent are assumed to be positive unless prefixed by a -. A blank entry in exp. is understood to be zero.
2. All quantities are held in the computer from run to run. If this is a series of runs and not the first of such a series it is necessary to specify only those parameters which changed from the preceding problem.
3. A series of runs should be stapled together and the order of running will coincide with the order in which they are presented.