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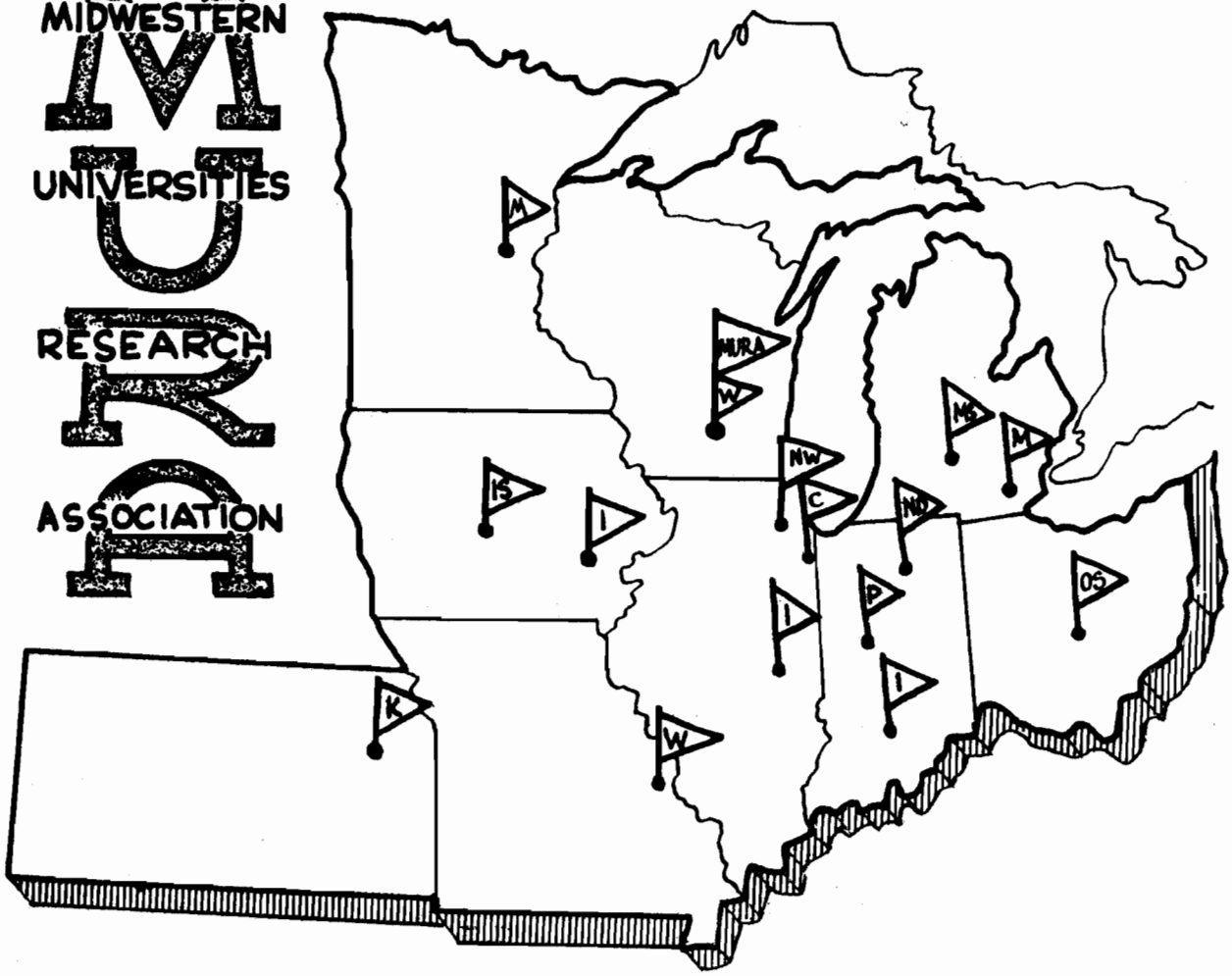

THEORY OF THE FIXED FREQUENCY CYCLOTRON

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REPORT NUMBER 498

MURA-498
Distribution List UC 28

MIDWESTERN UNIVERSITIES RESEARCH ASSOCIATION*

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THEORY OF THE FIXED FREQUENCY CYCLOTRON

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August 18, 1959

ABSTRACT

The results previously found for the linear orbit properties of an accelerator with a general magnetic field are applied to the fixed frequency cyclotron. The results of the theory are tested by applying them to the Berkeley cyclotron model.

*Research supported by the Atomic Energy Commission, Contract No. AEC AT (11-1)-384. Research and Development report.

**On leave from the University of Notre Dame.

THEORY OF THE FIXED FREQUENCY CYCLOTRON

The results found in the reports MURA-397 and MURA-451 for a general accelerator, which are summarized in the report MURA-454, can be applied to the fixed frequency cyclotron. Therefore, these results will not be given again here. In this report we will compare the results of the theory with computer results for the Berkeley[1] fixed-frequency cyclotron model.

A FORTRAN program has been written, called POLYTIRE, which evaluates the theoretical results summarized in MURA-454. The program lists not only the final result for the orbit properties such as the tune ν_r, ν_z, but also prints out the various terms in the theoretical formuli to allow one to pick out the important terms.

The Berkeley model has the magnetic field, in the median plane,

$$H_z = - \{ H_0(r) + 2 H_1(r) \cos N\theta \}$$

$$H_0(r) = 1 + .2888\, r^2 + .1153\, r^4 + .4175\, r^6 ,$$

$$H_1(r) = .65\, r + .4\, r^3 ,$$

$$N = 3 .$$

H_z is measured in units of $m\omega c/e$, and ω is the angular frequency of motion.

Figure 1 compares the theoretical and the numerically computed results for the tune ν_r, ν_z as a function of the velocity v.

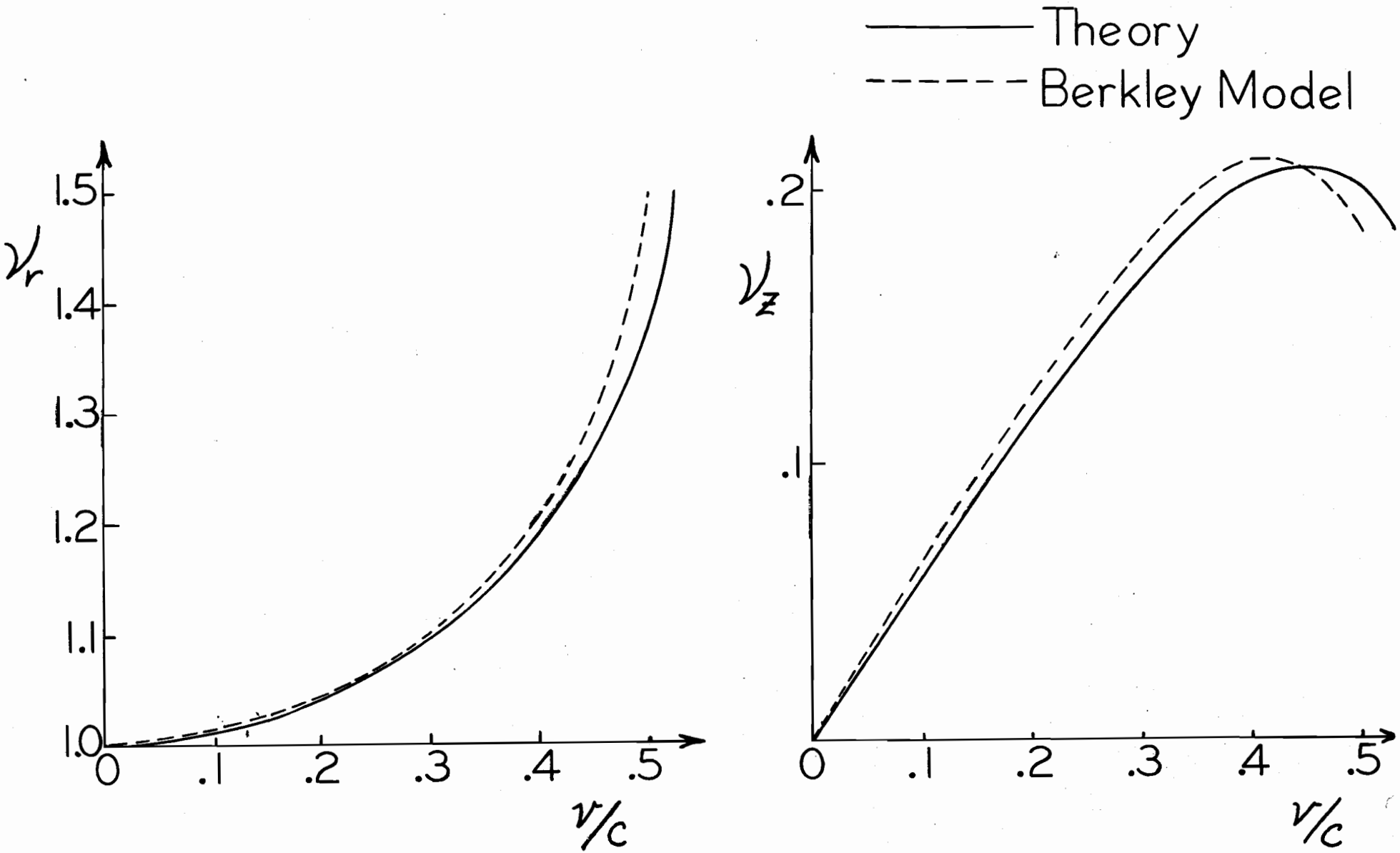
Table I compares results for the average magnetic $H_0(r)$ required to give a constant frequency of revolution. Eq. (16) in MURA-454 was used to find $H_0(r)$.

r	$H_0(r)$	
	Theory	Berkeley Model
0	1.00000	1.00000
.1	1.00284	1.00290
.2	1.01143	1.01176
.3	1.02648	1.02730
.4	1.04959	1.05087
.5	1.08509	1.08593

TABLE I. Comparison of the average field $H_0(r)$ required for isochronism.

REFERENCES

1. Kelly, Pyle, Thornton, Richardson, Wright, Rev. Sci. Instr. 27, 493 (1956).


Theory
Berkley Model
ν_r
1.5
1.4
1.3
1.2
1.1
1.0
0
.1
.2
.3
.4
.5
v/c
ν_z
.2
.1
0
.1
.2
.3
.4
.5
v/c