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EXPLORATION OF PHASE SPACE TRAJECTORIES
IN SIMULATIONS OF THE BEAM-BEAM INTERACTION

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I. INTRODUCTION

In previous papers^{1,2,3} we have investigated the effects of a non-linear "beam-beam" force on random diffusion in one-dimensional (1-D) motion. We found that diffusion can be enhanced substantially by the nonlinear force if the nonlinear force parameter ("beam-beam" tune shift) be large enough that a low order resonance is included within the tune spread. We developed a theoretical model to describe that diffusion enhancement and found excellent agreement between model calculations and numerical simulation results.

In this paper we begin a more systematic study of this 1-D diffusion enhancement. Phase space trajectories at noninteger tunes between 0.0 and 0.5 and tune shifts between 0.0 and 0.1 are explored. Phase space trajectories of particle orbits are plotted in the figures below. From these trajectories resonant widths can be measured directly, and from these resonant widths the effects on diffusion enhancement can be calculated using the theoretical model of reference 2. Important resonances can be identified by the magnitude of the distortions of phase space trajectories.

CALCULATION OF TRAJECTORIES

The equation of motion for trajectories is

$$x'' + k(s)x = -\frac{4\pi\Delta\nu}{\beta} F(x)x \delta_p(s) \quad (1)$$

$$\text{where } F(x) = \left[1. - \exp(-x^2/2\sigma^2) \right] / (x^2/2\sigma^2) \quad (2)$$

where $2\sigma^2 = 1/75 \text{ mm}^2$, a number chosen to simulate $\bar{p}p$ collisions in the Tevatron. The expression on the right of eq.(1) stands for the beam - beam interaction caused by the 1-D truncation of a "round" gaussian strong beam.

The simulations are catalogued by tunes v_0 and tune shifts Δv . Transport around the ring is represented by a Courant-Snyder (CS) matrix of the following form:

$$\begin{pmatrix} x \\ x' \end{pmatrix}_{\text{after}} = \begin{bmatrix} \cos(2\pi v) & \beta \sin(2\pi v) \\ (-1/\beta)\sin(2\pi v) & \cos(2\pi v) \end{bmatrix} \begin{pmatrix} x \\ x' \end{pmatrix}_{\text{before}}$$

v_0 is set as a multiple of 0.05. We choose v equal to $(v_0 - \Delta v)$ and set β as the solution of the equations

$$\cos(2\pi v_0^*) = \cos(2\pi v) - 2\pi v \sin(2\pi v)$$

$$\beta \sin(2\pi v) = \beta^* \sin(2\pi v_0^*)$$

with $\beta^* = 2.0 \text{ m}$, corresponding to $\bar{p}p$ Tevatron collisions. The beam-beam kick is simulated by the matrix multiplication

$$\begin{pmatrix} x \\ x' \end{pmatrix}_{\text{after}} = \begin{bmatrix} 1 & 0 \\ -\frac{4\pi\Delta v}{\beta^*} F(x) & 1 \end{bmatrix} \begin{pmatrix} x \\ x' \end{pmatrix}_{\text{before}}$$

For $v_0 = 0.0$ and $v_0 = 0.5$, the above procedure for finding β and v leads to a singularity at $\sin 2\pi v_0 = 0$. To avoid this we set $v_0 = .0001$ and $.4999$, respectively. For given Δv , v was found by solving the equation:

$$\cos(2\pi v) - 2\pi \Delta v \sin(2\pi v) = \cos[2\pi(0.0001 \text{ or } 0.4999)]$$

and β found from

$$\beta \sin(2\pi v) = \beta \sin 2\pi v_0^*$$

This procedure avoids $v = 0.0$ and 0.5 within the tune spread.

PHASE PLOT GENERATION

The phase plots below are generated by the following procedure:

Forty points along the x axis are chosen evenly spaced from $x = 0$ to $x = 10 \sigma$. The points are transported around the ring by 1/2 a beam-beam kick, the linear transport and 1/2 of a beam-beam kick to generate a new point which is plotted. The procedure is repeated until ~ 400 points for each initial position are generated. In this procedure, the particles' phase space position in the center of the interaction region is generated and plotted.

In Table I below the symbols corresponding to the different trajectories are identified. In Table II, the values of v and Δv , β are summarized. The "tune spread" of this table has v at the lower limit and v_0^* as the upper with v_0^* given by the solution of

$$\cos(2v_0^*\pi) = \cos(2\pi v) - 2\pi\Delta v \sin(2\pi v)$$

In Figs. 1 - 191 phase space trajectories for 191 values of $(v_0, \Delta v)$ are plotted. This includes tunes v_0 of 0.05, 0.10, 0.15, ..., 0.50 and $\Delta v = 0.0, 0.005, 0.01, 0.015, \dots, 0.10$. The figures are organized by increasing values of $v_0 = v + \Delta v$, the tune at zero amplitude, and decreasing Δv at fixed v_0 . This allows the reader to follow development of resonant features with increasing tune shift. Features associated with $1/4, n/6, n/8$ and $n/10$ resonances are clearly visible. Higher order resonance features can also be seen on some plots.

In a future paper we will calculate diffusion enhancement for each of these cases and compare with model predictions.

REFERENCES

1. D. Neuffer and A. G. Ruggiero, Fermilab FN-325, Proc. of the Beam Beam Interaction Seminar, SLAC, 1980.
2. D. Neuffer, A. Riddiford, and A. G. Ruggiero - A Model to Describe Diffusion Enhancement by the Beam-Beam Interaction, Fermilab TM-1007, 1980.
3. D. Neuffer, A. Riddiford and A. G. Ruggiero, IEEE Trans. on Nucl. Science, Vol. NS-28, p. 2494, 1981.

TABLE I. Correlation of the trajectory symbols shown in Figures 1-191 with the initial values of X_0 (mm).
 $X_0 = A\sigma$, $A = 0.25, 0.5, \dots, 10$; $\sigma = 0.08165$ mm; $X'_0 = 0$

Δ	$+$	Δ	γ	ϕ	x	\square	z	\diamond	χ
0.0204	0.0408	0.0612	0.0816	0.1021	0.1225	0.1429	0.1633	0.1837	0.2401
0.2245	^{3σ} 0.2449	0.2654	0.2858	0.3062	^{4σ} 0.3266	0.3470	0.3674	0.3878	0.4082
0.4287	0.4491	0.4695	^{6σ} 0.4899	0.5103	0.5307	0.5511	^{7σ} 0.5715	0.5920	0.6124
0.6328	^{8σ} 0.6532	0.6736	0.6940	0.7144	^{9σ} 0.7348	0.7553	0.7757	0.7961	^{10σ} 0.8165

TABLE II Ring parameters.

 Initial emittance = 0.020 mm-mrad.
$$\begin{pmatrix} X \\ X' \end{pmatrix}_{n+1} = \begin{bmatrix} D_1 & D_2 \\ D_3 & D_4 \end{bmatrix} \begin{pmatrix} X \\ X' \end{pmatrix}_n$$

Fig.	$\Delta\nu$	Tune Spread	D1=D4	D2 (m)	D3 (m ⁻¹)	$4\pi\Delta\nu/\beta$ (m ⁻¹)	β (m)
1	0	0.0001, 0.0001	1.00	0.0013	-0.00031	0	2
2	0.050	0.0001, 0.0032	1.00	0.040	-10 ⁻⁵	0.0099	63.3
3	0.045	0.005, 0.0218	1.00	0.27	-0.0036	0.065	8.70
4	0.040	0.010, 0.0300	1.00	0.38	-0.011	0.084	5.98
5	0.035	0.015, 0.0358	1.00	0.45	-0.020	0.093	4.73
6	0.030	0.020, 0.0401	0.99	0.50	-0.032	0.095	3.97
7	0.025	0.025, 0.0434	0.99	0.54	-0.045	0.091	3.44
8	0.020	0.030, 0.0459	0.98	0.57	-0.062	0.083	3.03
9	0.015	0.035, 0.0477	0.98	0.59	-0.081	0.070	2.71
10	0.010	0.040, 0.0490	0.97	0.61	-0.10	0.052	2.44
11	0.005	0.045, 0.0498	0.96	0.62	-0.13	0.028	2.20
12	0	0.05, 0.05	0.95	0.62	-0.15	0	2
13	0.100	0.0001, 0.0045	1.00	0.056	-7x10 ⁻⁶	0.014	89.5
14	0.095	0.005, 0.0313	1.00	0.39	-0.0025	0.096	12.4
15	0.090	0.010, 0.0437	1.00	0.54	-0.0073	0.13	8.64
16	0.085	0.015, 0.0529	1.00	0.65	-0.014	0.15	6.93
17	0.080	0.020, 0.0603	0.99	0.74	-0.021	0.17	5.90
18	0.075	0.025, 0.0665	0.99	0.81	-0.030	0.18	5.19
19	0.070	0.030, 0.0718	0.98	0.87	-0.040	0.19	4.65
20	0.065	0.035, 0.0765	0.98	0.92	-0.051	0.19	4.24
21	0.060	0.040, 0.0805	0.97	0.97	-0.064	0.19	3.90
22	0.055	0.045, 0.0840	0.96	1.01	-0.077	0.19	3.61
23	0.050	0.050, 0.0871	0.95	1.04	-0.092	0.19	3.37
24	0.045	0.055, 0.0898	0.94	1.07	-0.11	0.18	3.16
25	0.040	0.060, 0.0921	0.93	1.09	-0.12	0.17	2.97
26	0.035	0.065, 0.0941	0.92	1.11	-0.14	0.16	2.81
27	0.030	0.070, 0.0957	0.90	1.13	-0.16	0.14	2.66
28	0.025	0.075, 0.0971	0.89	1.15	-0.18	0.12	2.52
29	0.020	0.080, 0.0982	0.88	1.16	-0.20	0.10	2.40
30	0.015	0.085, 0.0990	0.86	1.17	-0.22	0.082	2.29
31	0.010	0.090, 0.0996	0.84	1.17	-0.25	0.058	2.19
32	0.005	0.095, 0.0999	0.83	1.17	-0.27	0.030	2.09
33	0	0.1, 0.1	0.81	1.18	-0.29	0	2

TABLE II (continued)

Fig.	$\Delta\nu$	Tune Spread	D1=D4	D2 (m)	D3 (m ⁻¹)	$4\pi\Delta\nu/\beta$ (m ⁻¹)	β (m)
34	0.100	0.050, 0.1134	0.95	1.31	-0.073	0.30	4.23
35	0.095	0.055, 0.1177	0.94	1.35	-0.085	0.30	3.98
36	0.090	0.060, 0.1217	0.93	1.38	-0.10	0.30	3.76
37	0.085	0.065, 0.1253	0.92	1.42	-0.11	0.30	3.57
38	0.080	0.070, 0.1286	0.90	1.45	-0.13	0.30	3.40
39	0.075	0.075, 0.1316	0.89	1.47	-0.14	0.29	3.24
40	0.070	0.080, 0.1343	0.88	1.49	-0.16	0.28	3.10
41	0.065	0.085, 0.1368	0.86	1.51	-0.17	0.27	2.98
42	0.060	0.090, 0.1390	0.84	1.53	-0.19	0.26	2.86
43	0.055	0.095, 0.1409	0.83	1.55	-0.20	0.25	2.76
44	0.050	0.100, 0.1427	0.81	1.56	-0.22	0.24	2.66
45	0.045	0.105, 0.1442	0.79	1.57	-0.24	0.22	2.57
46	0.040	0.110, 0.1455	0.77	1.58	-0.26	0.20	2.49
47	0.035	0.115, 0.1467	0.75	1.59	-0.27	0.18	2.41
48	0.030	0.120, 0.1476	0.73	1.60	-0.29	0.16	2.34
49	0.025	0.125, 0.1484	0.71	1.61	-0.31	0.14	2.27
50	0.020	0.130, 0.1490	0.68	1.61	-0.33	0.11	2.21
51	0.015	0.135, 0.1494	0.66	1.61	-0.35	0.088	2.15
52	0.010	0.140, 0.1498	0.64	1.62	-0.37	0.060	2.10
53	0.005	0.145, 0.1499	0.61	1.62	-0.39	0.031	1.05
54	0	0.15, 0.15	0.59	1.62	-0.40	0	2
55	0.100	0.100, 0.1775	0.81	1.80	-0.19	0.41	3.06
56	0.095	0.105, 0.1803	0.79	1.81	-0.21	0.40	2.95
57	0.090	0.110, 0.1828	0.77	1.82	-0.22	0.40	2.86
58	0.085	0.115, 0.1850	0.75	1.84	-0.24	0.38	2.78
59	0.080	0.120, 0.1871	0.73	1.85	-0.25	0.37	2.70
60	0.075	0.125, 0.1890	0.71	1.85	-0.27	0.36	2.62
61	0.070	0.130, 0.1907	0.68	1.86	-0.29	0.34	2.56
62	0.065	0.135, 0.1922	0.66	1.87	-0.30	0.33	2.49
63	0.060	0.140, 0.1936	0.64	1.88	-0.32	0.31	2.43
64	0.055	0.145, 0.1948	0.61	1.88	-0.33	0.29	2.38

TABLE II (continued)

Fig.	$\Delta\nu$	Tune Spread	D1=D4	D2 (m)	D3 (m ⁻¹)	$4\pi\Delta\nu/\beta$ (m ⁻¹)	β (m)
65	0.050	0.150,0.1959	0.59	1.89	-0.35	0.27	2.33
66	0.045	0.155,0.1968	0.56	1.89	-0.36	0.25	2.28
67	0.040	0.160,0.1975	0.54	1.89	-0.38	0.22	2.24
68	0.035	0.165,0.1982	0.51	1.90	-0.39	0.20	2.20
69	0.030	0.170,0.1987	0.48	1.90	-0.41	0.17	2.16
70	0.025	0.175,0.1992	0.45	1.90	-0.42	0.15	2.13
71	0.020	0.180,0.1995	0.43	1.90	-0.43	0.12	2.10
72	0.015	0.185,0.1997	0.40	1.90	-0.44	0.091	2.07
73	0.010	0.190,0.1999	0.37	1.90	-0.45	0.061	2.05
74	0.005	0.195,0.2000	0.34	1.90	-0.47	0.031	2.02
75	0	0.2,0.2	0.31	1.90	-0.48	0	2
76	0.100	0.150,0.2373	0.59	1.99	-0.33	0.51	2.46
77	0.095	0.155,0.2391	0.56	2.00	-0.34	0.49	2.41
78	0.090	0.160,0.2407	0.54	2.00	-0.36	0.48	2.36
79	0.085	0.165,0.2421	0.51	2.00	-0.37	0.46	2.32
80	0.080	0.170,0.2434	0.48	2.00	-0.38	0.44	2.28
81	0.075	0.175,0.2446	0.45	2.00	-0.40	0.42	2.24
82	0.070	0.180,0.2456	0.43	2.00	-0.41	0.40	2.21
83	0.065	0.185,0.2464	0.40	2.00	-0.42	0.37	2.18
84	0.060	0.190,0.2472	0.37	2.00	-0.43	0.35	2.15
85	0.055	0.195,0.2478	0.34	2.00	-0.44	0.33	2.13
86	0.050	0.200,0.2484	0.31	2.00	-0.45	0.30	2.10
87	0.045	0.205,0.2488	0.28	2.00	-0.46	0.27	2.08
88	0.040	0.210,0.2492	0.25	2.00	-0.47	0.24	2.06
89	0.035	0.215,0.2494	0.22	2.00	-0.48	0.21	2.05
90	0.030	0.220,0.2496	0.19	2.00	-0.48	0.19	2.04
91	0.025	0.225,0.2498	0.16	2.00	-0.49	0.16	2.02
92	0.020	0.230,0.2499	0.13	2.00	-0.49	0.12	2.02
93	0.015	0.235,0.2500	0.094	2.00	-0.50	0.094	2.01
94	0.010	0.240,0.2500	0.063	2.00	-0.50	0.063	2.00
95	0.005	0.245,0.2500	0.031	2.00	-0.50	0.031	2.00
96	0	0.25,0.25	0	2	-0.50	0	2

TABLE II (continued)

Fig.	$\Delta \gamma$	Tune Spread	D1=D4	D2 (m)	D3 (m ⁻¹)	$4\pi \Delta \gamma / \beta$ (m ⁻¹)	β (m)
97	0.100	0.200, 0.2966	0.31	1.91	-0.47	0.62	2.01
98	0.095	0.205, 0.2975	0.28	1.91	-0.48	0.60	1.99
99	0.090	0.210, 0.2983	0.25	1.91	-0.49	0.57	1.97
100	0.085	0.215, 0.2990	0.22	1.91	-0.50	0.55	1.95
101	0.080	0.220, 0.2996	0.19	1.90	-0.51	0.52	1.94
102	0.075	0.225, 0.3000	0.16	1.90	-0.51	0.49	1.93
103	0.070	0.230, 0.3003	0.13	1.90	-0.52	0.46	1.92
104	0.065	0.235, 0.3006	0.094	1.90	-0.52	0.43	1.91
105	0.060	0.240, 0.3007	0.063	1.90	-0.52	0.40	1.90
106	0.055	0.245, 0.3008	0.031	1.90	-0.53	0.36	1.90
107	0.050	0.250, 0.3009	0	1.90	-0.53	0.33	1.90
108	0.045	0.255, 0.3008	-0.031	1.90	-0.53	0.30	1.90
109	0.040	0.260, 0.3008	-0.063	1.90	-0.52	0.26	1.90
110	0.035	0.265, 0.3007	-0.094	1.90	-0.52	0.23	1.91
111	0.030	0.270, 0.3006	-0.13	1.90	-0.52	0.20	1.92
112	0.025	0.275, 0.3004	-0.16	1.90	-0.51	0.16	1.92
113	0.020	0.280, 0.3003	-0.19	1.90	-0.51	0.13	1.94
114	0.015	0.285, 0.3002	-0.22	1.90	-0.50	0.097	1.95
115	0.010	0.290, 0.3001	-0.25	1.90	-0.49	0.064	1.96
116	0.005	0.295, 0.3000	-0.28	1.90	-0.48	0.032	1.98
117	0	0.3, 0.3	-0.31	1.90	-0.48	0	2
118	0.100	0.250, 0.3581	0	1.56	-0.64	0.81	1.56
119	0.095	0.255, 0.3581	-0.031	1.56	-0.64	0.77	1.56
120	0.090	0.260, 0.3579	-0.063	1.56	-0.64	0.72	1.56
121	0.085	0.265, 0.3576	-0.094	1.56	-0.64	0.68	1.57
122	0.080	0.270, 0.3573	-0.13	1.56	-0.63	0.64	1.58
123	0.075	0.275, 0.3568	-0.16	1.57	-0.62	0.59	1.59
124	0.070	0.280, 0.3563	-0.19	1.57	-0.61	0.55	1.60
125	0.065	0.285, 0.3558	-0.22	1.57	-0.60	0.51	1.61
126	0.060	0.290, 0.3552	-0.25	1.58	-0.59	0.46	1.63
127	0.055	0.295, 0.3546	-0.28	1.58	-0.58	0.42	1.65

TABLE II (continued)

Fig.	$\Delta\nu$	Tune Spread	D1=D4	D2 (m)	D3 (m ⁻¹)	$4\pi\Delta\nu/\beta$ (m ⁻¹)	β (m)
128	0.050	0.300, 0.3540	-0.31	1.59	-0.57	0.38	1.67
129	0.045	0.305, 0.3534	-0.34	1.59	-0.56	0.33	1.69
130	0.040	0.310, 0.3528	-0.37	1.60	-0.54	0.29	1.72
131	0.035	0.315, 0.3522	-0.40	1.60	-0.53	0.25	1.75
132	0.030	0.320, 0.3517	-0.43	1.61	-0.51	0.21	1.77
133	0.025	0.325, 0.3512	-0.45	1.61	-0.49	0.17	1.81
134	0.020	0.330, 0.3508	-0.48	1.61	-0.48	0.14	1.84
135	0.015	0.335, 0.3505	-0.51	1.61	-0.46	0.10	1.88
136	0.010	0.340, 0.3502	-0.54	1.62	-0.44	0.066	1.91
137	0.005	0.345, 0.3501	-0.56	1.62	-0.42	0.032	1.96
138	0	0.35, 0.35	-0.59	1.62	-0.40	0	2
139	0.100	0.300, 0.4307	-0.31	0.84	-1.07	1.42	0.89
140	0.095	0.305, 0.4283	-0.34	0.87	-1.02	1.29	0.93
141	0.090	0.310, 0.4206	-0.37	0.90	-0.96	1.17	0.96
142	0.085	0.315, 0.4237	-0.40	0.92	-0.91	1.06	1.01
143	0.080	0.320, 0.4214	-0.43	0.95	-0.86	0.96	1.05
144	0.075	0.325, 0.4192	-0.45	0.97	-0.82	0.86	1.09
145	0.070	0.330, 0.4170	-0.48	1.00	-0.77	0.77	1.14
146	0.065	0.335, 0.4149	-0.51	1.02	-0.73	0.69	1.18
147	0.060	0.340, 0.4130	-0.53	1.04	-0.69	0.61	1.23
148	0.055	0.345, 0.4111	-0.56	1.06	-0.65	0.54	1.28
149	0.050	0.350, 0.4093	-0.59	1.08	-0.61	0.47	1.33
150	0.045	0.355, 0.4076	-0.61	1.10	-0.57	0.41	1.39
151	0.040	0.360, 0.4061	-0.64	1.11	-0.53	0.35	1.44
152	0.035	0.365, 0.4048	-0.66	1.13	-0.50	0.29	1.50
153	0.030	0.370, 0.4036	-0.68	1.14	-0.47	0.24	1.56
154	0.025	0.375, 0.4025	-0.71	1.15	-0.44	0.19	1.63
155	0.020	0.380, 0.4016	-0.73	1.16	-0.40	0.15	1.69
156	0.015	0.385, 0.4009	-0.75	1.17	-0.38	0.11	1.76
157	0.010	0.390, 0.4004	-0.77	1.17	-0.35	0.068	1.84
158	0.005	0.395, 0.4001	-0.79	1.17	-0.32	0.032	1.92
159	0	0.4, 0.4	-0.81	1.18	-0.29	0	2

TABLE II (continued)

Fig.	Δv	Tune Spread	D1=D4	D2 (m)	D3 (m ⁻¹)	$4\pi \Delta v / \beta$ (m ⁻¹)	β
160	0.050	0.400, 0.4821	-0.81	0.22	-1.54	1.64	0.38
161	0.045	0.405, 0.4733	-0.83	0.33	-0.95	0.95	0.59
162	0.040	0.410, 0.4673	-0.84	0.41	-0.70	0.66	0.76
163	0.035	0.415, 0.4627	-0.86	0.46	-0.56	0.48	0.91
164	0.030	0.420, 0.4591	-0.88	0.51	-0.46	0.36	1.06
165	0.025	0.425, 0.4562	-0.89	0.54	-0.38	0.26	1.20
166	0.020	0.430, 0.4539	-0.90	0.57	-0.32	0.19	1.34
167	0.015	0.435, 0.4522	-0.92	0.59	-0.27	0.13	1.49
168	0.010	0.440, 0.4510	-0.93	0.61	-0.22	0.076	1.65
169	0.005	0.445, 0.4502	-0.94	0.62	-0.19	0.035	1.82
170	0	0.45, 0.45	-0.95	0.62	-0.15	0	2
171	0.100	0.3214, 0.4999	-0.43	0.0013	-646	901	0.0014
172	0.095	0.3287, 0.4999	-0.47		-617	836	0.0014
173	0.090	0.3362, 0.4999	-0.52		-584	771	0.0015
174	0.085	0.3439, 0.4999	-0.56		-550	706	0.0015
175	0.080	0.3517, 0.4999	-0.60		-513	642	0.0016
176	0.075	0.3598, 0.4999	-0.64		-473	578	0.0016
177	0.070	0.3681, 0.4999	-0.68		-432	516	0.0017
178	0.065	0.3765, 0.4999	-0.71		-390	455	0.0018
179	0.060	0.3852, 0.4999	-0.75		-347	396	0.0019
180	0.055	0.3941, 0.4999	-0.79		-303	340	0.0020
181	0.050	0.4031, 0.4999	-0.82		-260	286	0.0022
182	0.045	0.4123, 0.4999	-0.85		-218	236	0.0024
183	0.040	0.4216, 0.4999	-0.88		-178	189	0.0027
184	0.035	0.4311, 0.4999	-0.91		-140	147	0.0030
185	0.030	0.4407, 0.4999	-0.93		-105	109	0.0035
186	0.025	0.4504, 0.4999	-0.95		-75	77	0.0041
187	0.020	0.4602, 0.4999	-0.97		-49	49	0.0051
188	0.015	0.4701, 0.4999	-0.98		-28	28	0.0067
189	0.010	0.4800, 0.4999	-0.99		-12	13	0.010
190	0.005	0.4900, 0.4999	-1.00		-3.1	3.1	0.020
191	0	0.4999, 0.4999	-1.00	0.0013	-0.0003	0	2

Figure 1
TM-1054

Figure 1 (X, X') Phase Space

$\gamma = 0.0001$; $\Delta\gamma = 0.0000$; $X'_0 = 0$
 $X_0 = 0.25\sigma, 0.5\sigma, \dots, 10\sigma$
 $\sigma = 0.08165$ mm; 400 turns

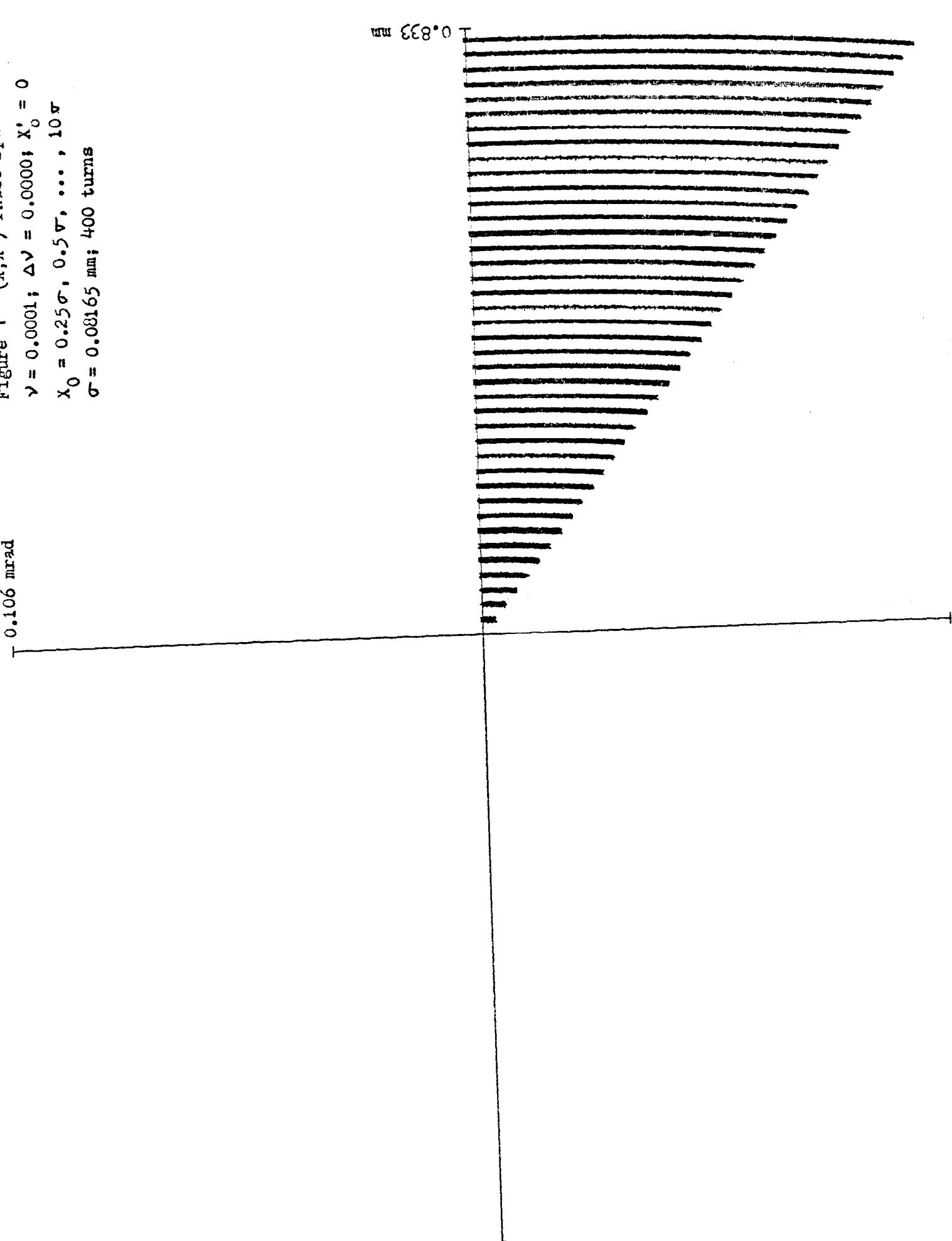


Figure 2

TM-1054

Figure 2 (λ, λ') Phase Space
 $\gamma = 0.0001$; $\Delta\gamma = 0.05$; $X'_0 = 0$
 $X_0 = 0.25\sigma, 0.5\sigma, \dots, 10\sigma$
 $\sigma = 0.08165 \text{ mm}$; 400 turns

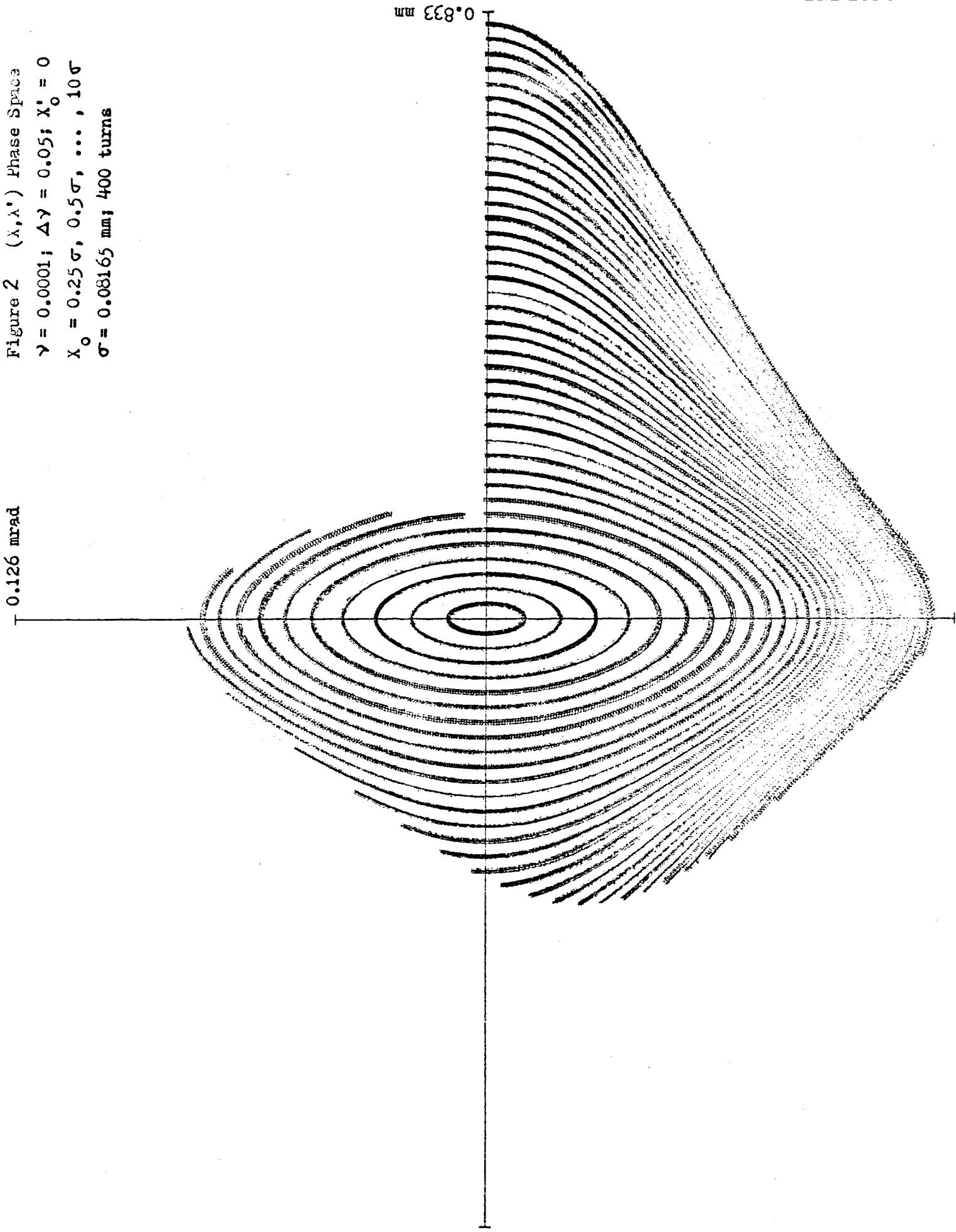


Figure 3
TM-1054

Figure 3 (λ, X') Phase Plane
 $v = 0.005$; $\Delta v = 0.045$
 100 turns

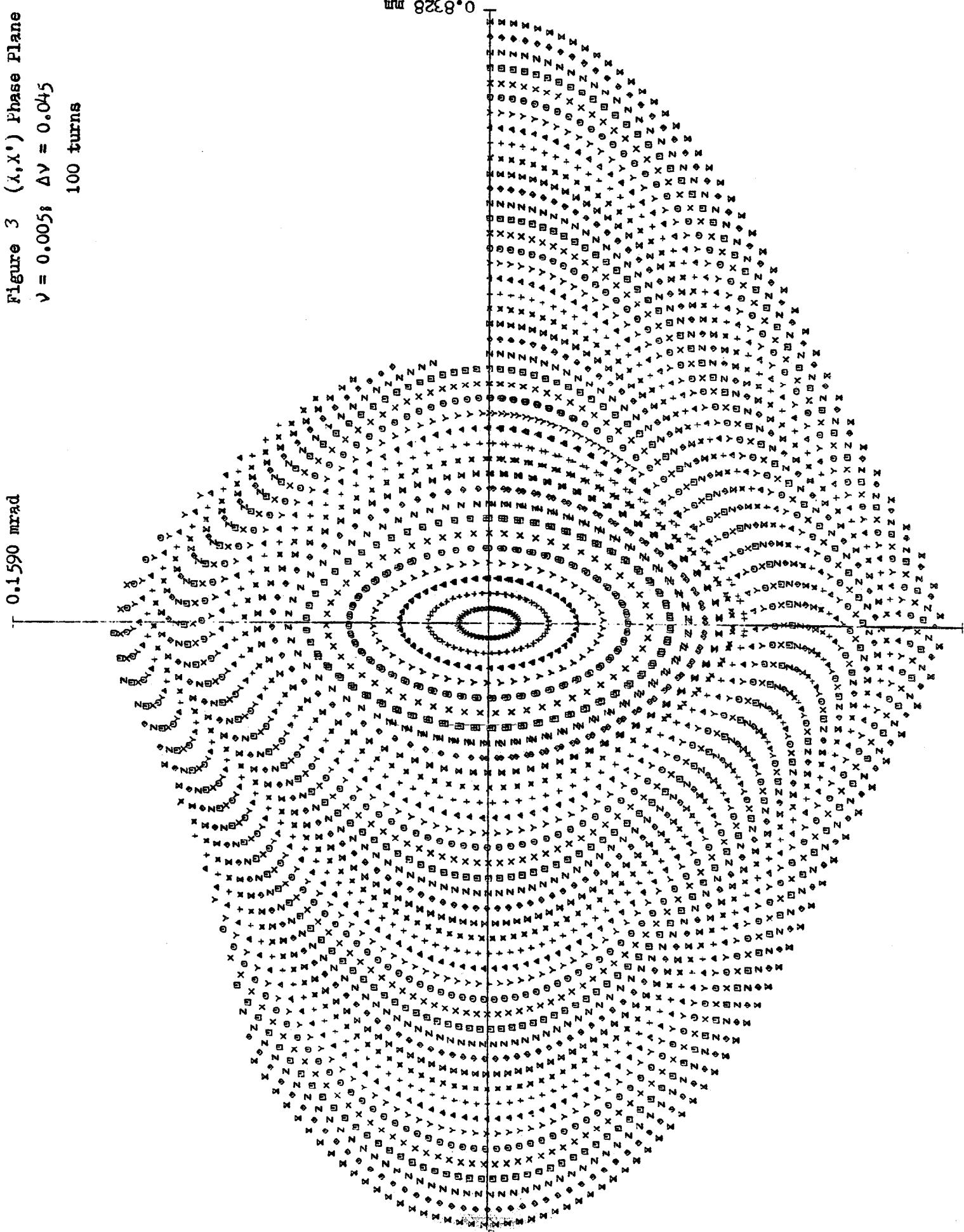
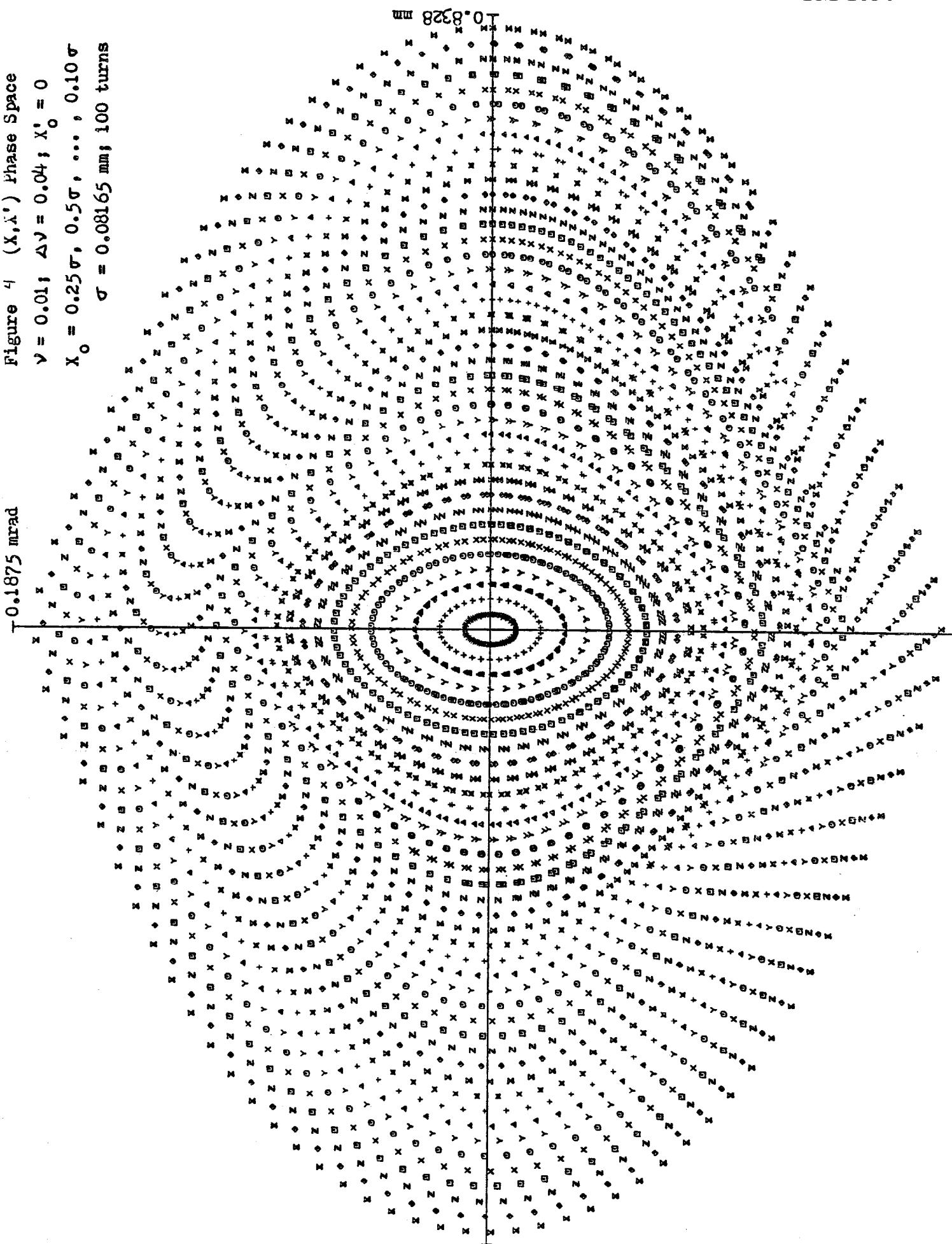


Figure 4
TM-1054

Figure 4 (X, X') Phase Space
 $\nu = 0.01; \Delta\nu = 0.04; X'_0 = 0$
 $X_0 = 0.25\sigma, 0.5\sigma, \dots, 0.10\sigma$
 $\sigma = 0.08165 \text{ mm}; 100 \text{ turns}$



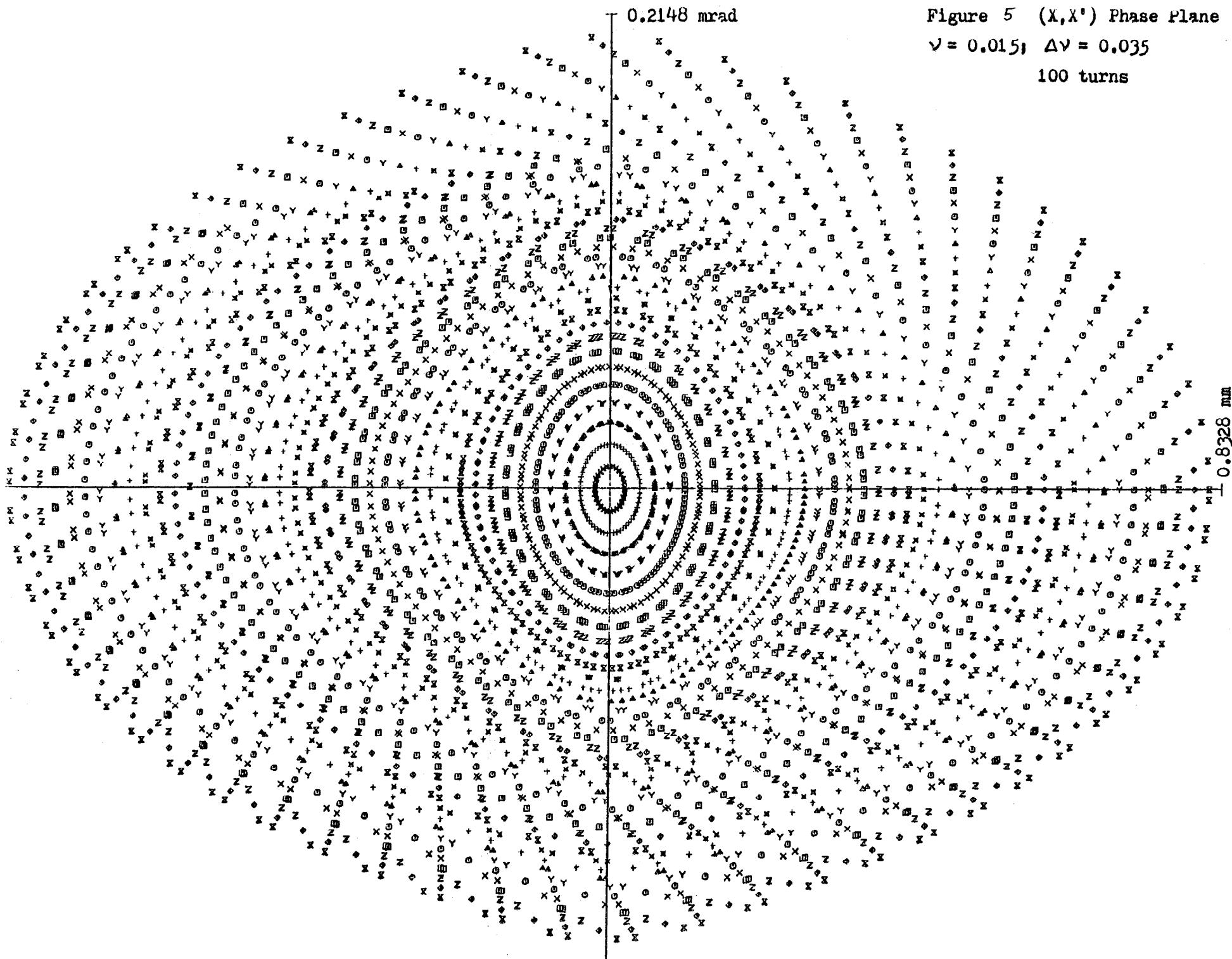


Figure 5 (x, x') Phase Plane
 $v = 0.015$; $\Delta v = 0.035$
100 turns

Figure 6 (X, X') Phase Space

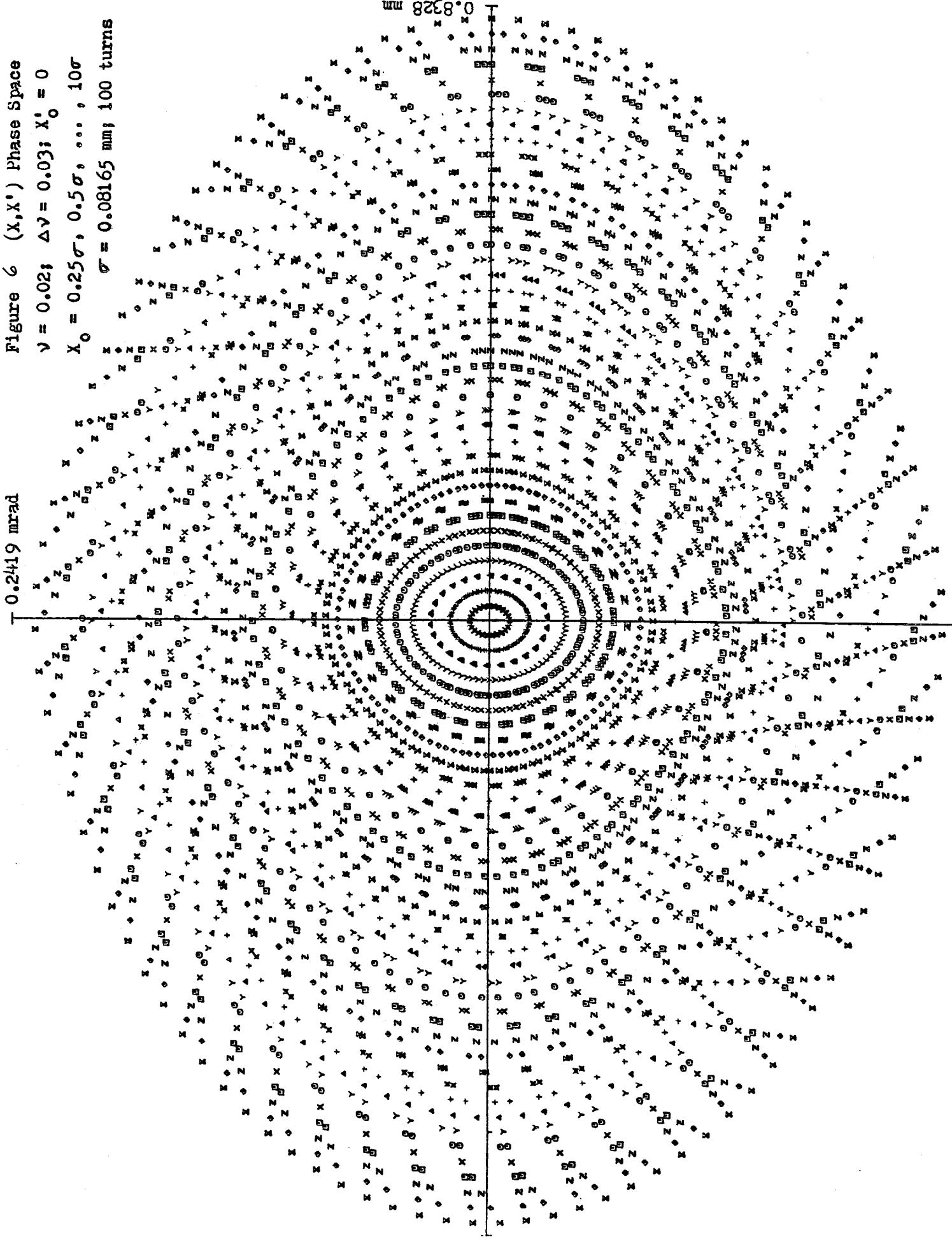


Figure 7
TM-1054

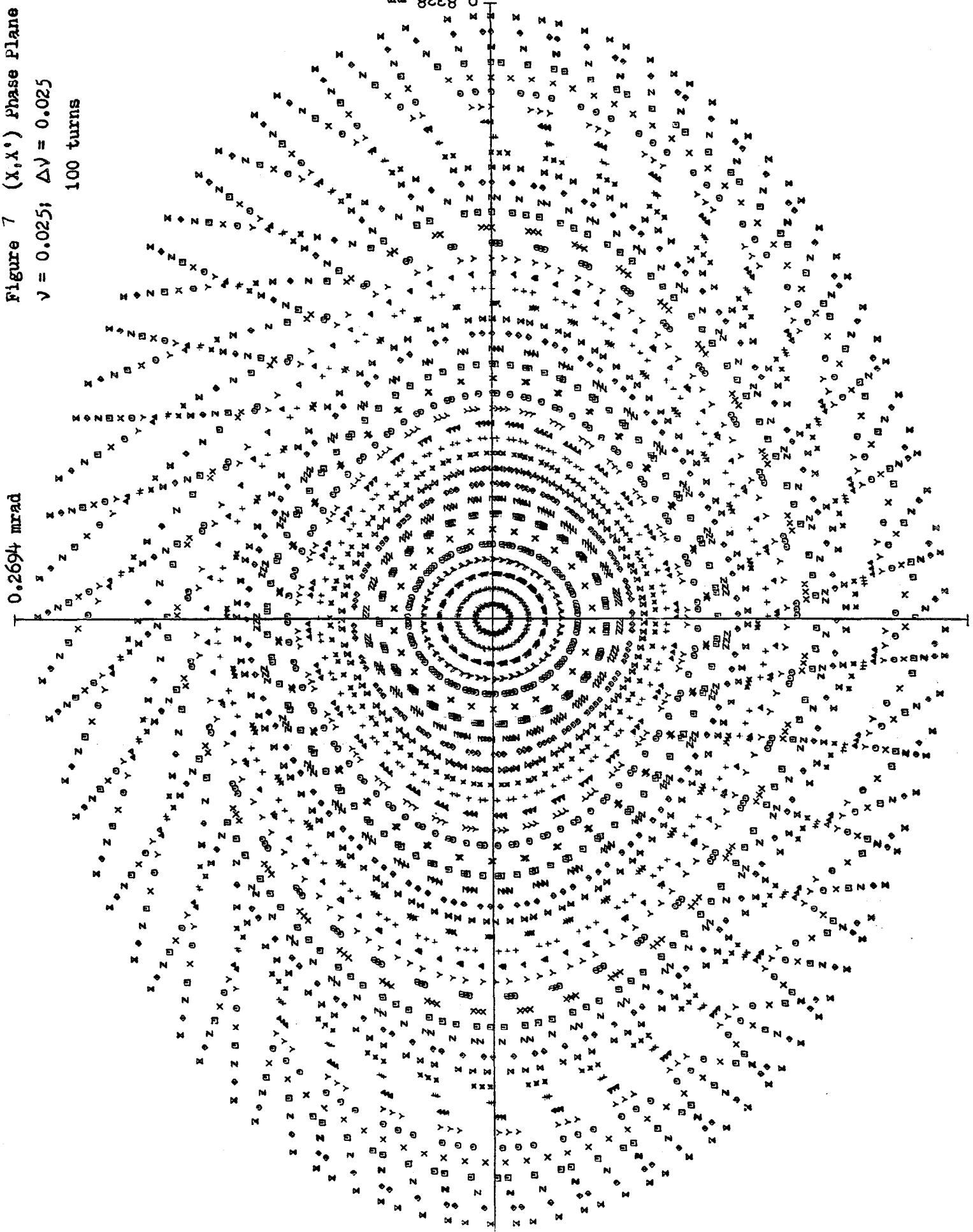


Figure 8
TM-1054

Figure 8 (X, X') Phase Space
 $\gamma = 0.03; \Delta Y = 0.02; X_0' = 0$
400 turns

0.298 mrad.

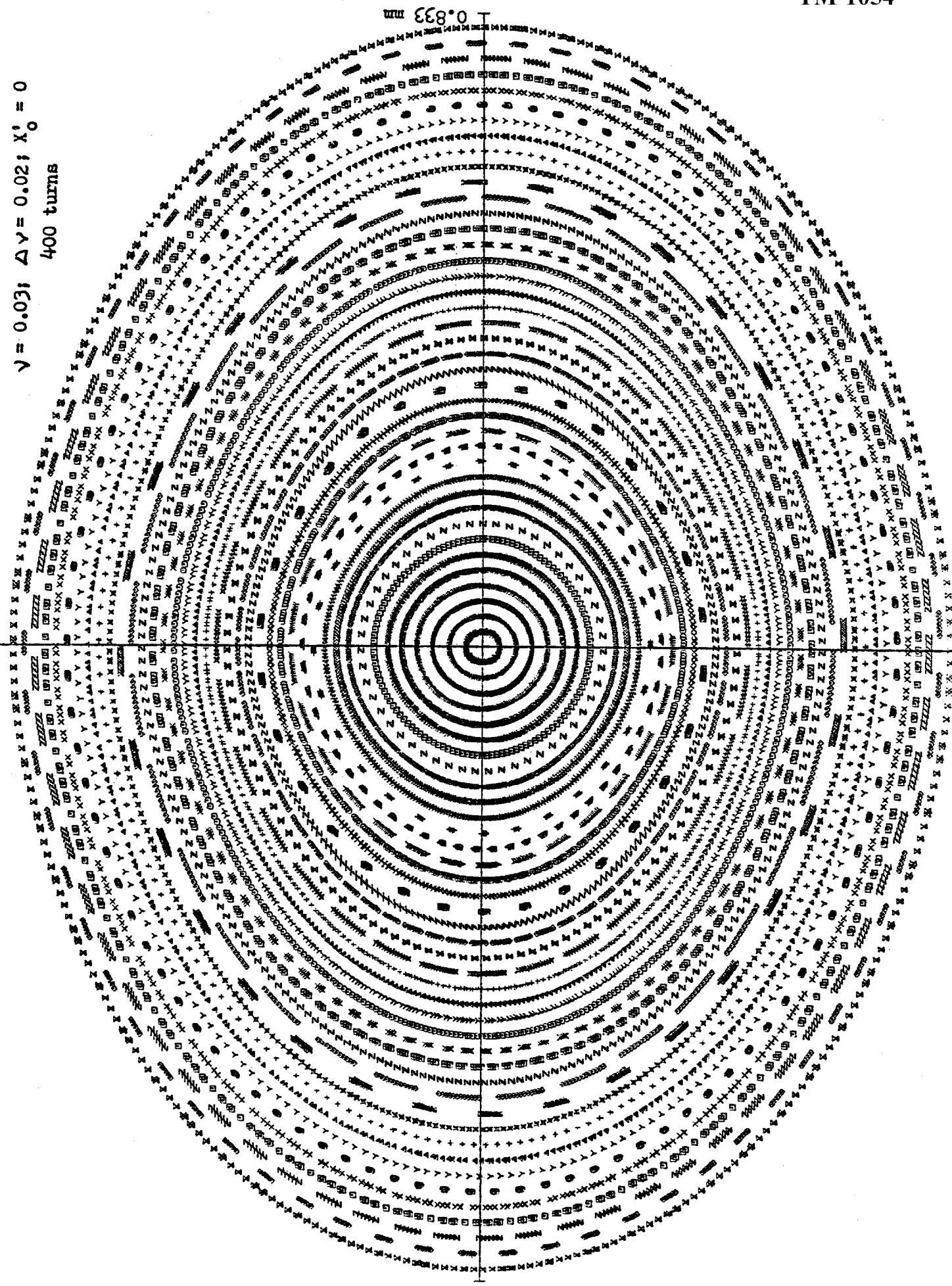


Figure 9
TM-1054

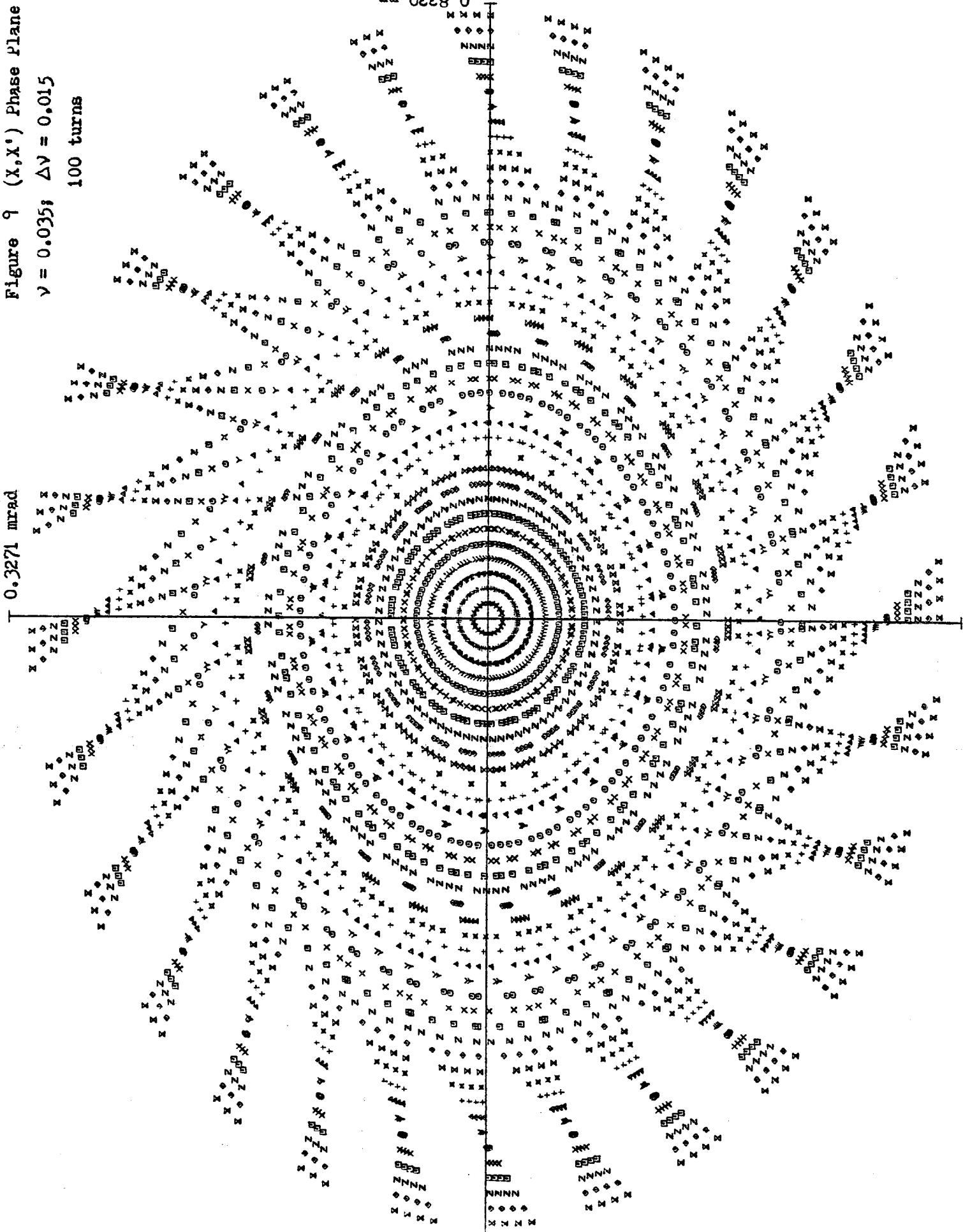


Figure 10
TM-1054

Figure 10 (X, X') Phase Space

$\gamma = 0.04; \Delta v = 0.01$
 $t = 0.358 \text{ mrad}$

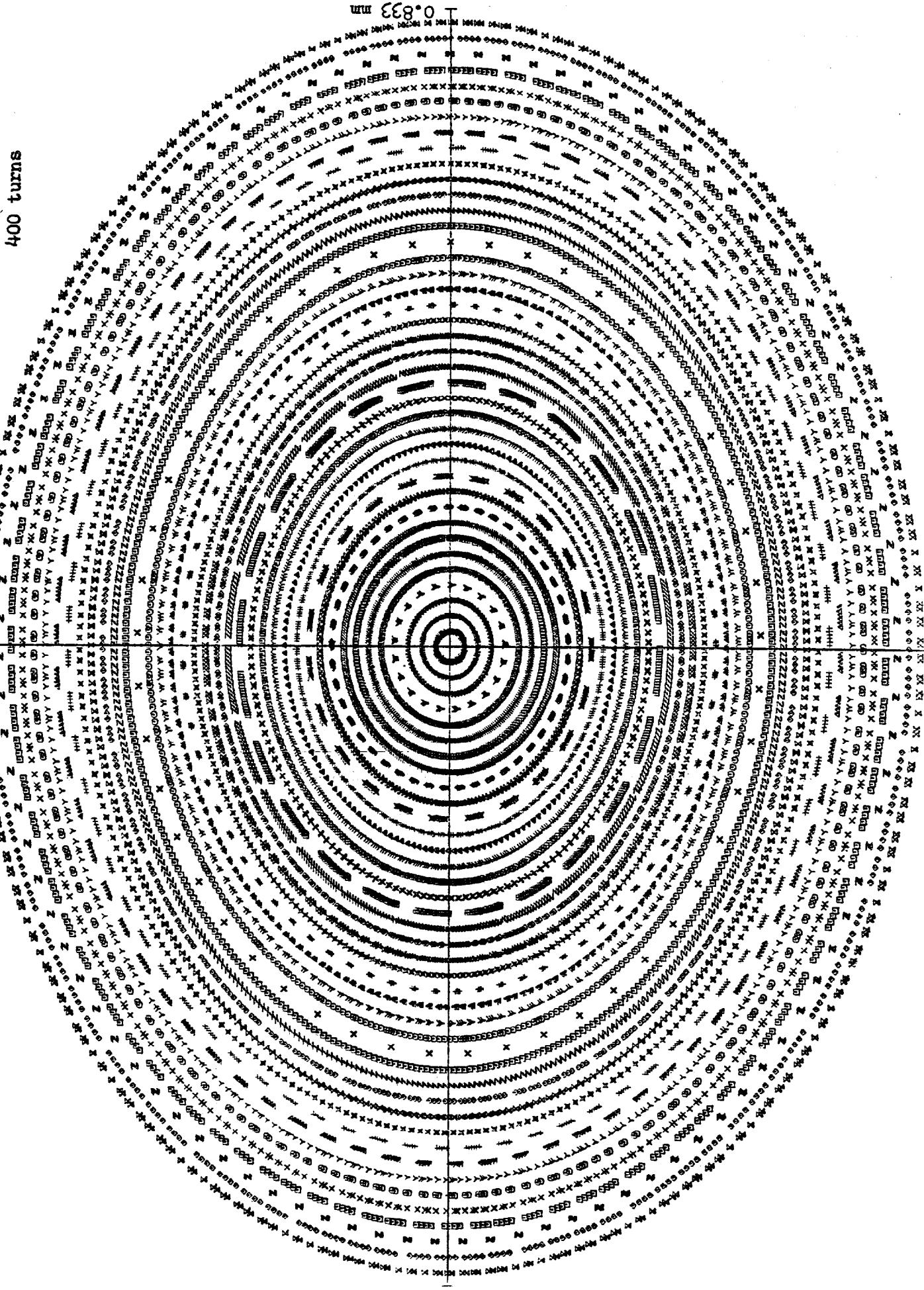


Figure 11
TM-1054

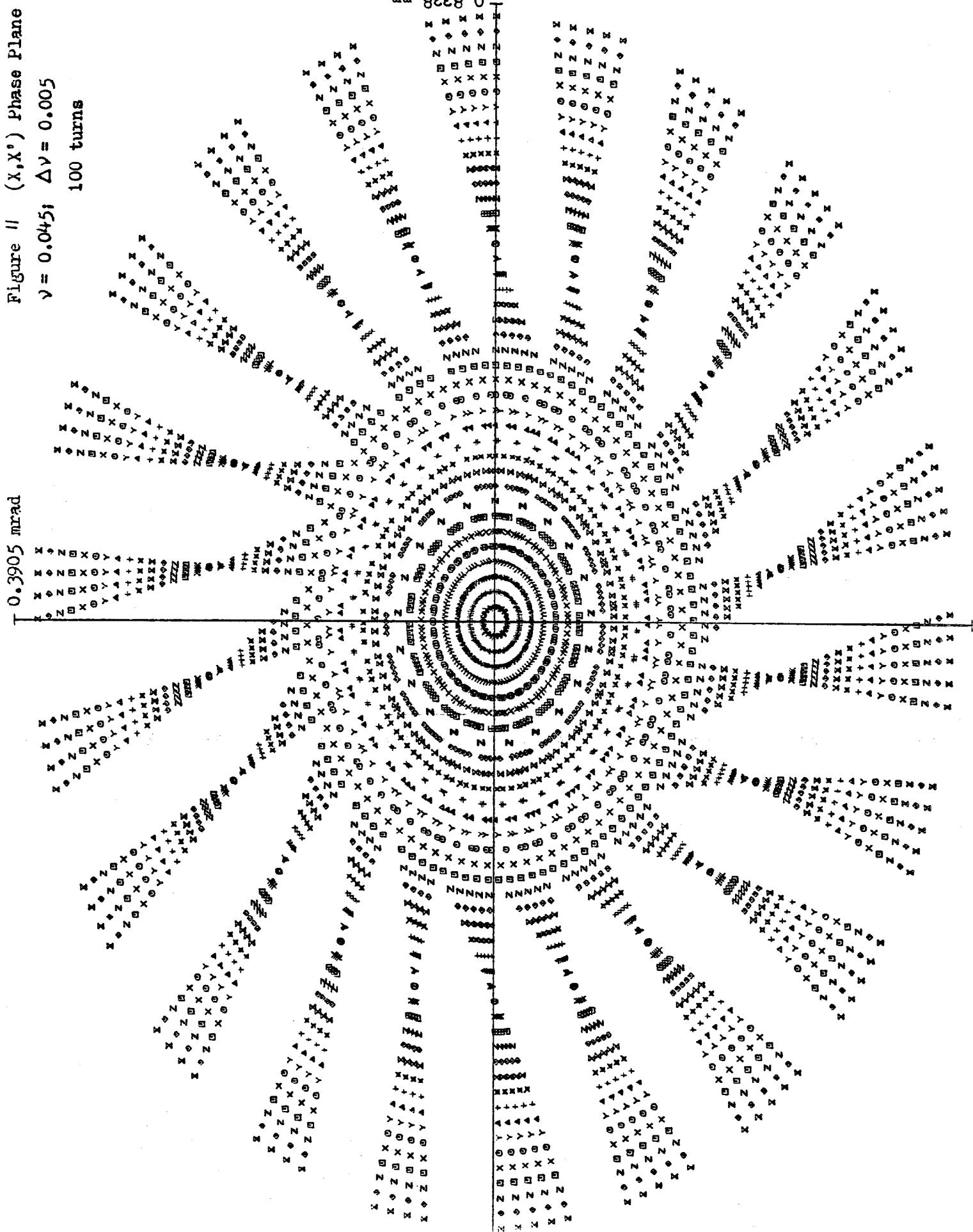


Figure 12
TM-1054

Figure 12 (X, X') Phase Plane
 $\gamma\sigma = 0.05$; $\Delta\vartheta = 0.00$; $X'_0 = 0$
 $X_0 = 0.25\sigma, 0.5\sigma, \dots, 10\sigma$
 $\sigma = 0.08165$ mm; 400 turns

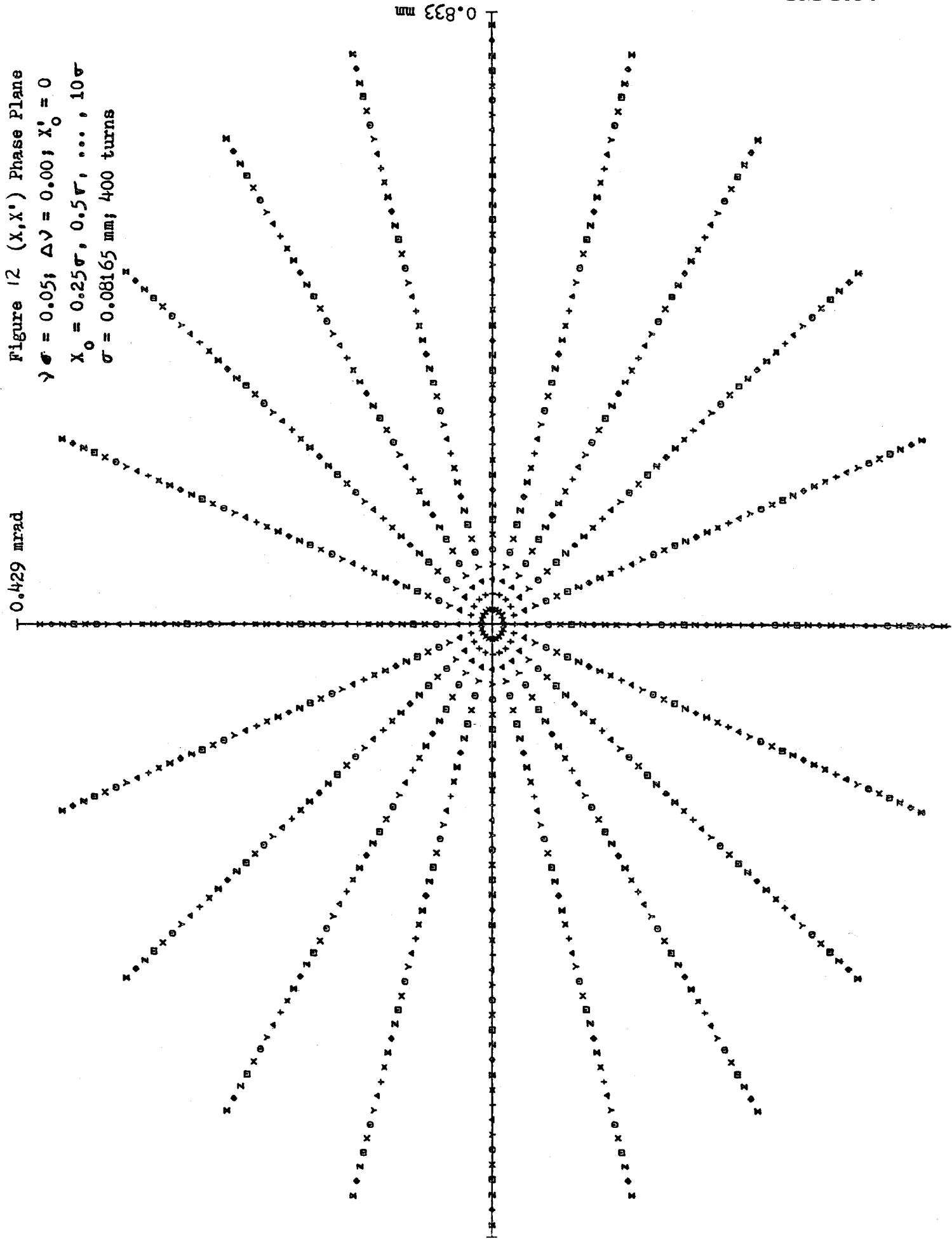


Figure 13 (X, X') Phase Space

$\gamma = 0.0001$; $\Delta\gamma = 0.10$; $X'_0 = 0$
 $X_0 = 0.25\sigma, 0.5\sigma, \dots, 10\sigma$
 $\sigma = 0.08165 \text{ mm}; 400 \text{ turns}$

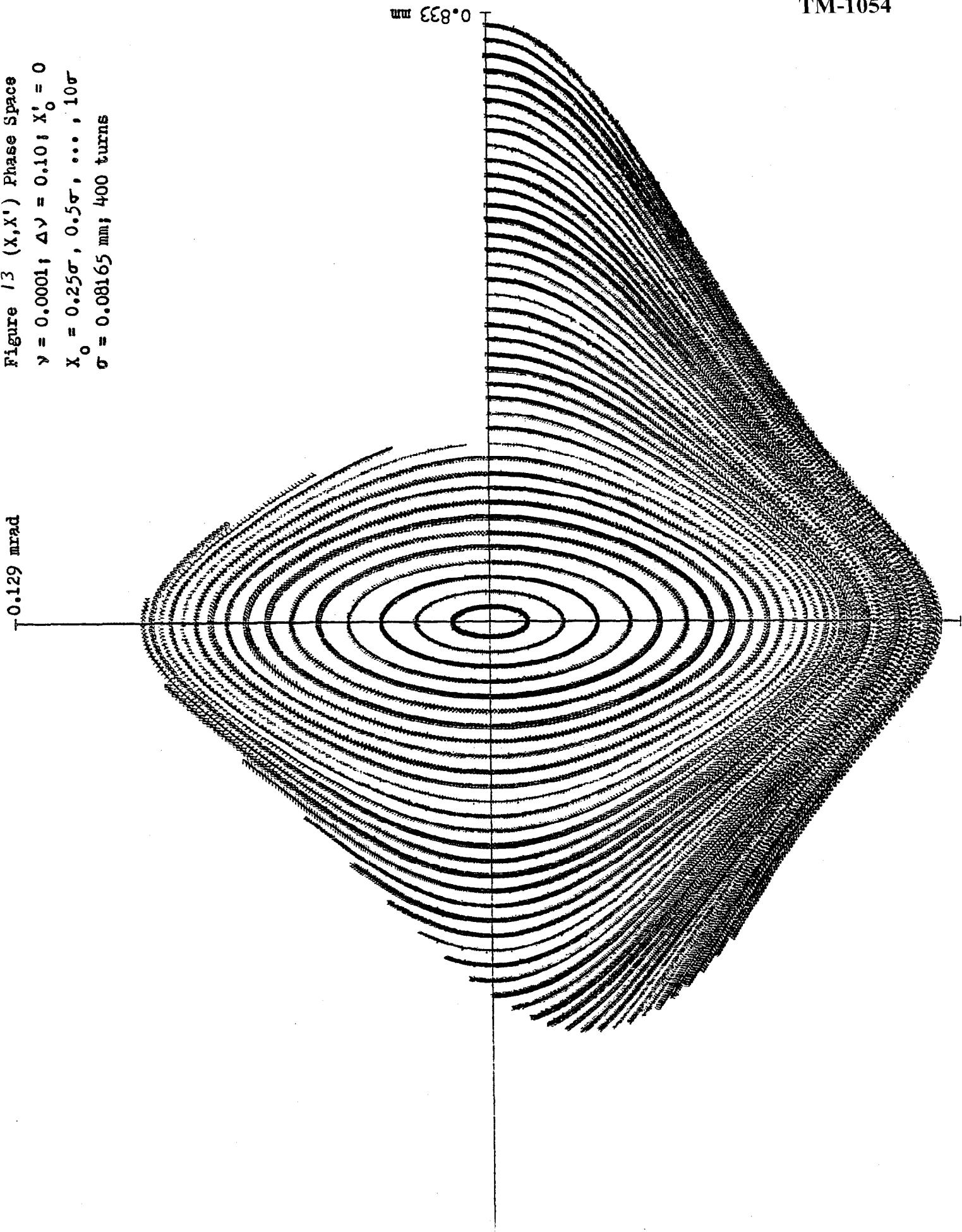


Figure 14 (X, X') Phase Plane $\gamma = 0.005; \Delta\gamma = 0.095$

100 turns

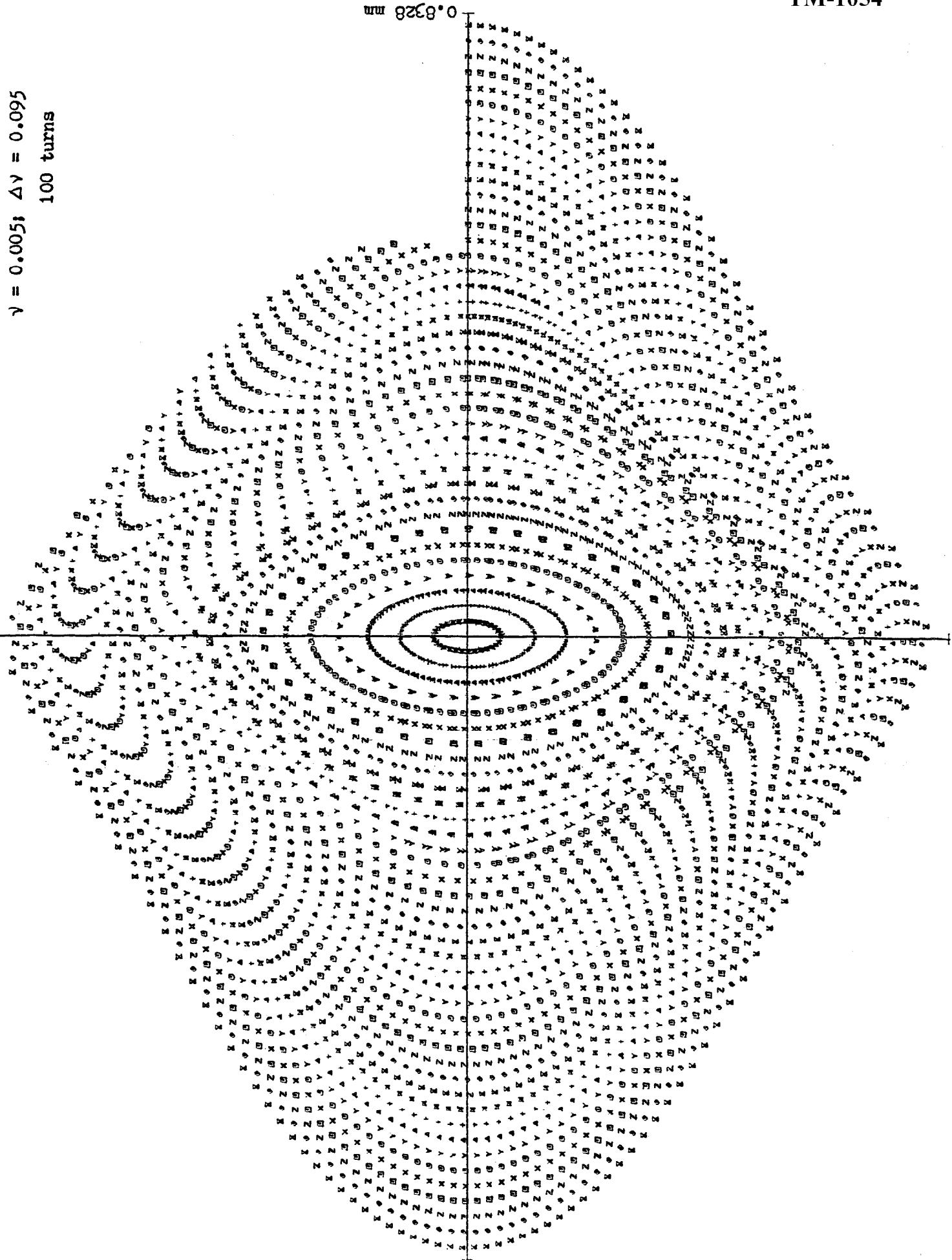
 $T = 0.1442 \text{ mrad}$ 

Figure 15 (X, X') Phase Plane
 $\gamma = 0.01$; $\Delta\gamma = 0.09$; $X_0' = 0$
 $X_0 = 0.25\sigma$, 0.5σ , ..., 10σ
 $\sigma = 0.08165$ mm; 100 turns

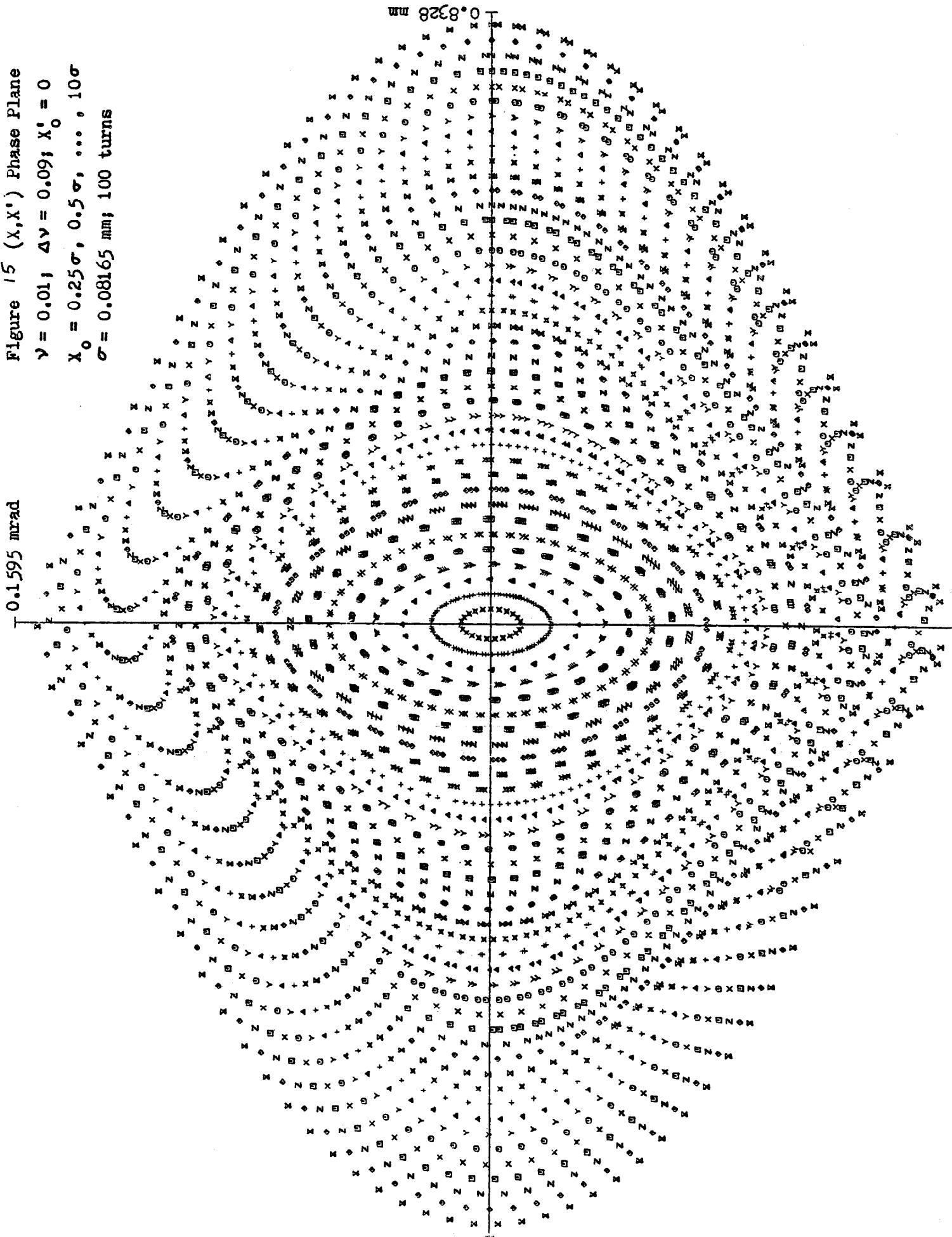


Figure 16 (λ, χ^*) Phase Plane $\nu = 0.0151$

100 turns

T 0.1740 mrad

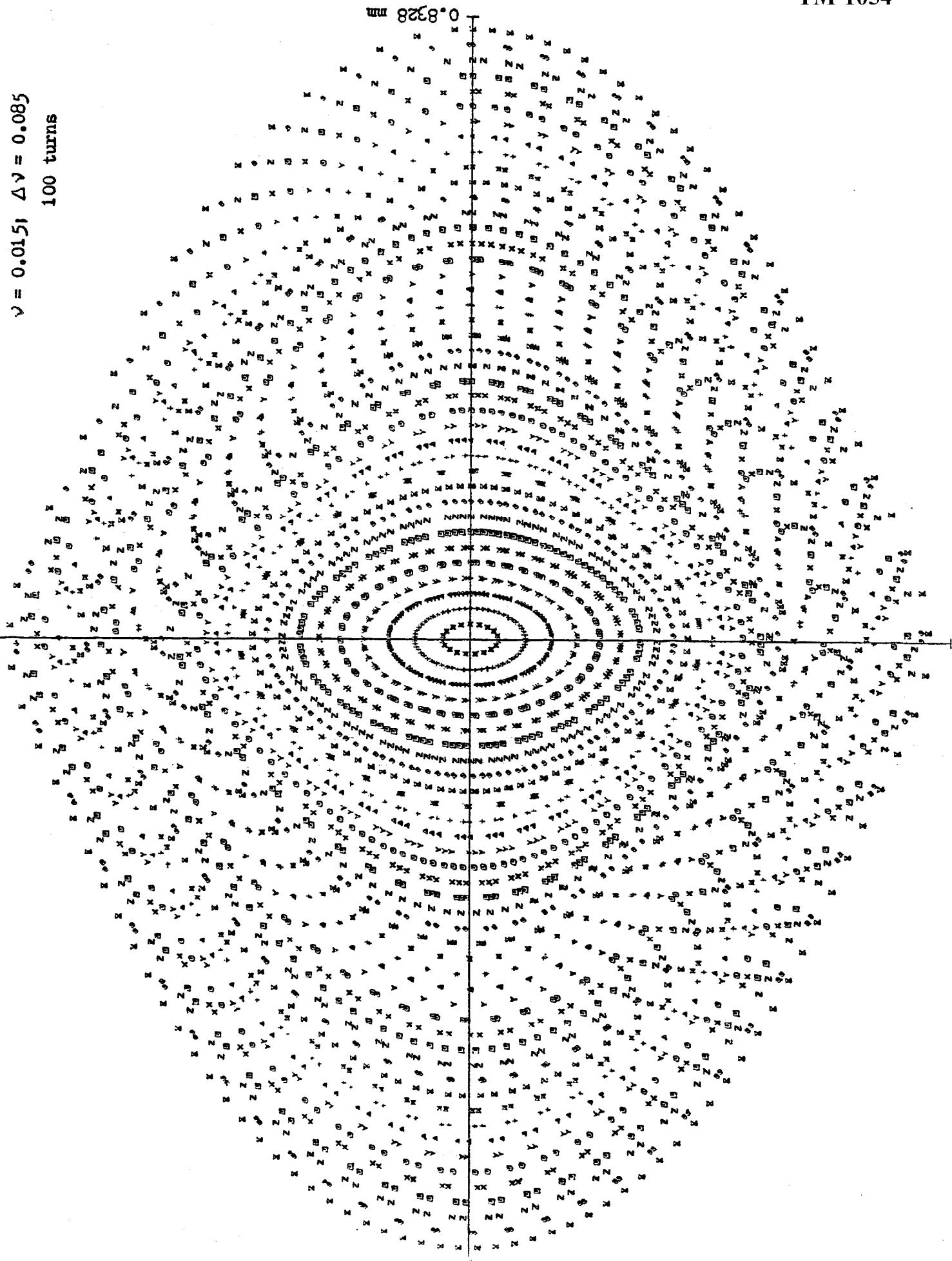


Figure 17 (X, X') Phase Plane

$\gamma = 0.02; \Delta\gamma = 0.08$

100 turns

0.1882 mrad

0.832 mm

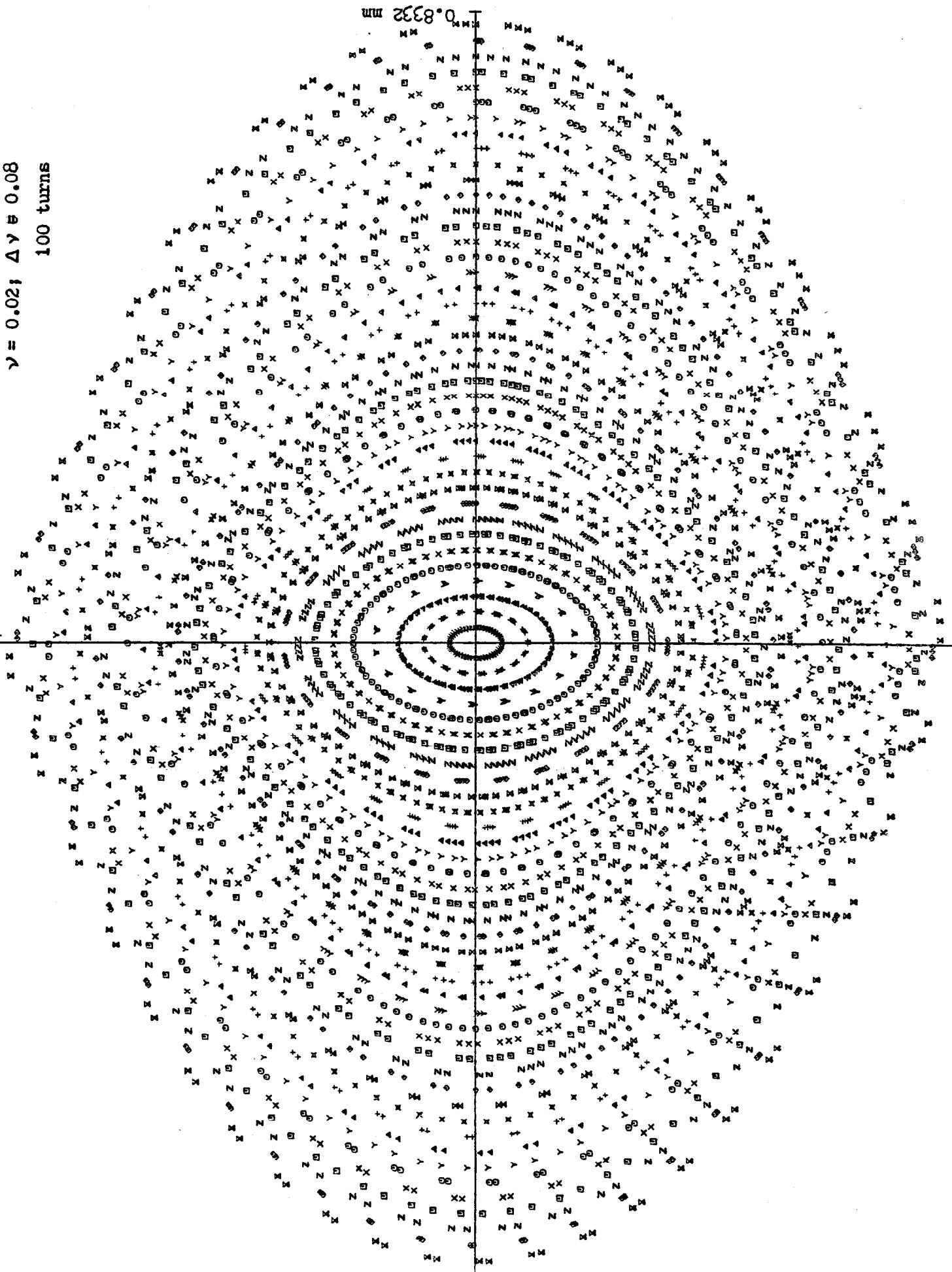


Figure 18 (λ, X^0) Phase Plane
 $\gamma = 0.025$; $\Delta\psi = 0.075$
100 turns

0.2020 mrad

0.839 mm

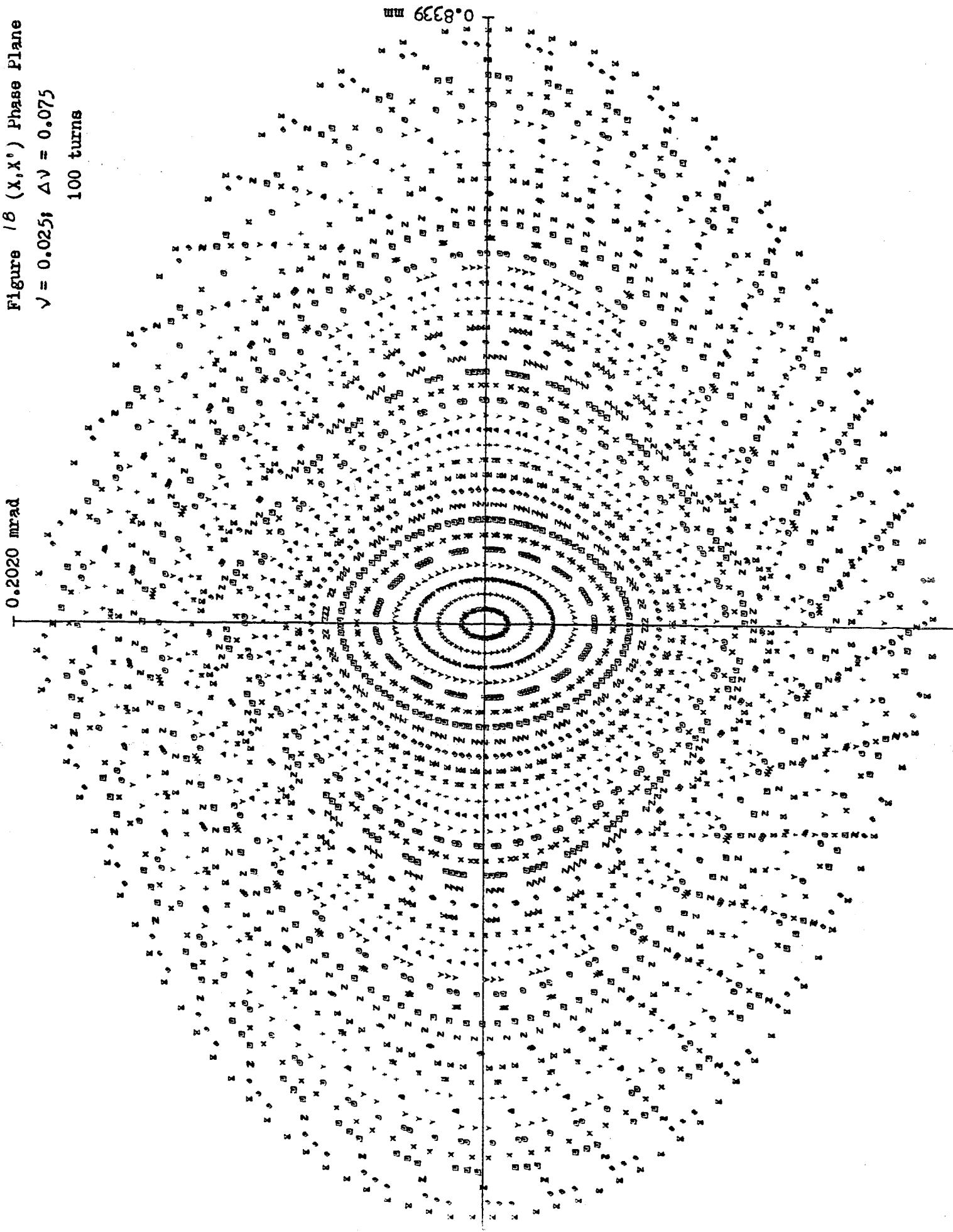


Figure 19
TM-1054

Figure 19 (X, X') Phase Plane
 $\gamma = 0.03$; $\Delta y = 0.07$

0.2152 mrad

0.8328 mm

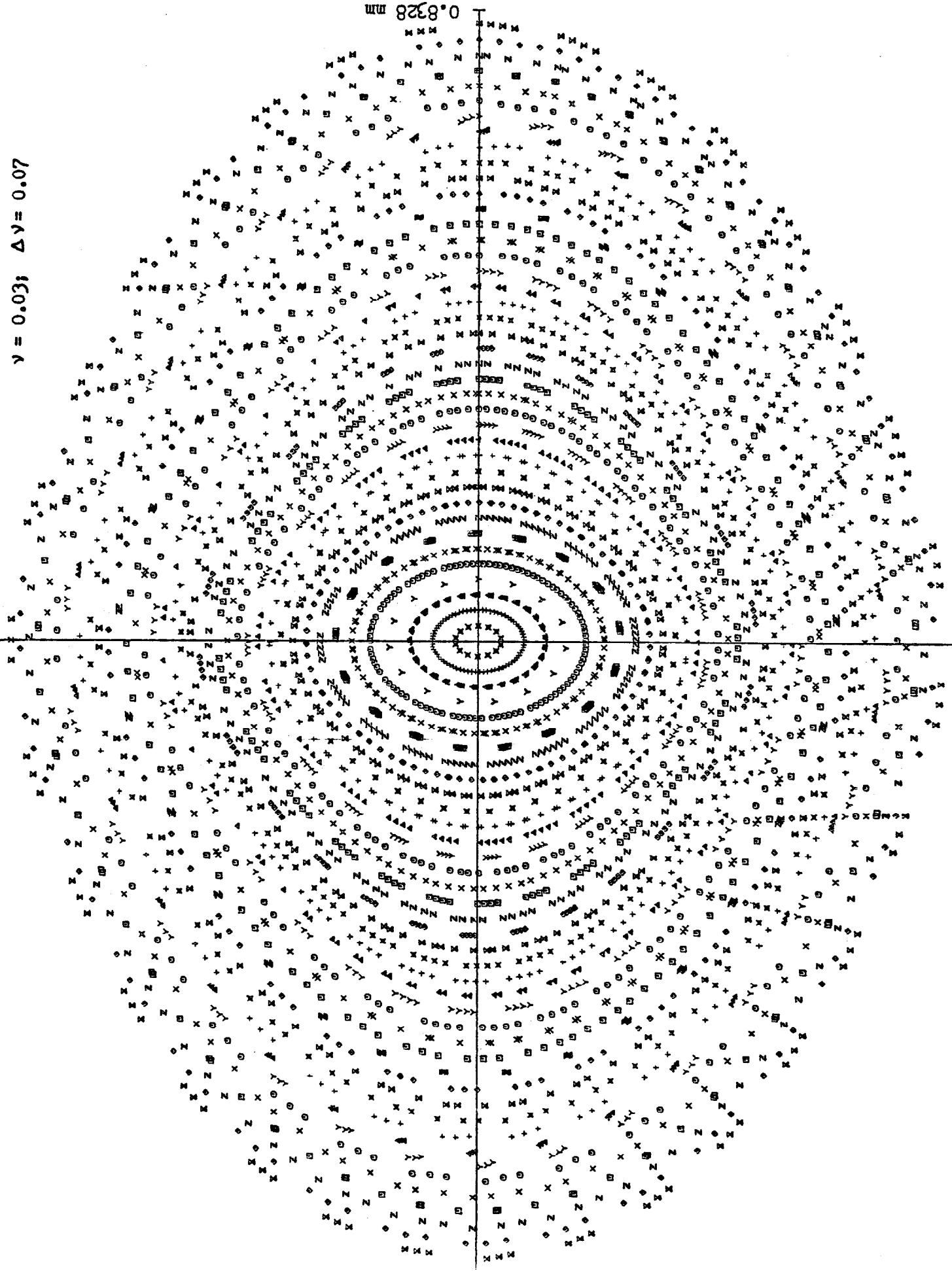


Figure 20
TM-1054

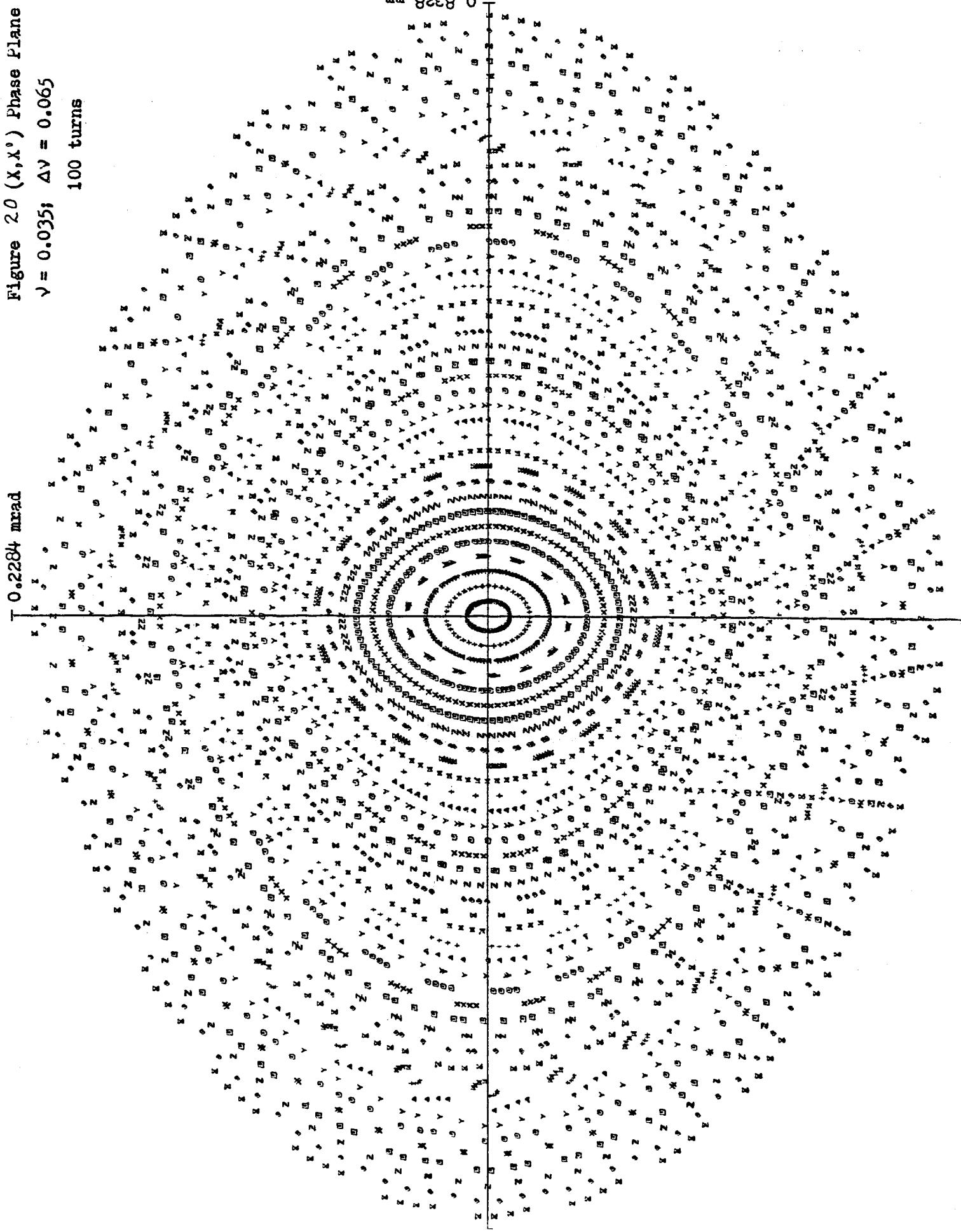


Figure 21
TM-1054

Figure 21 (X, X') Phase Plane

$\gamma = 0.04$; $\Delta\gamma = 0.06$

100 Turns

0.2427 mrad

0.8328 mm

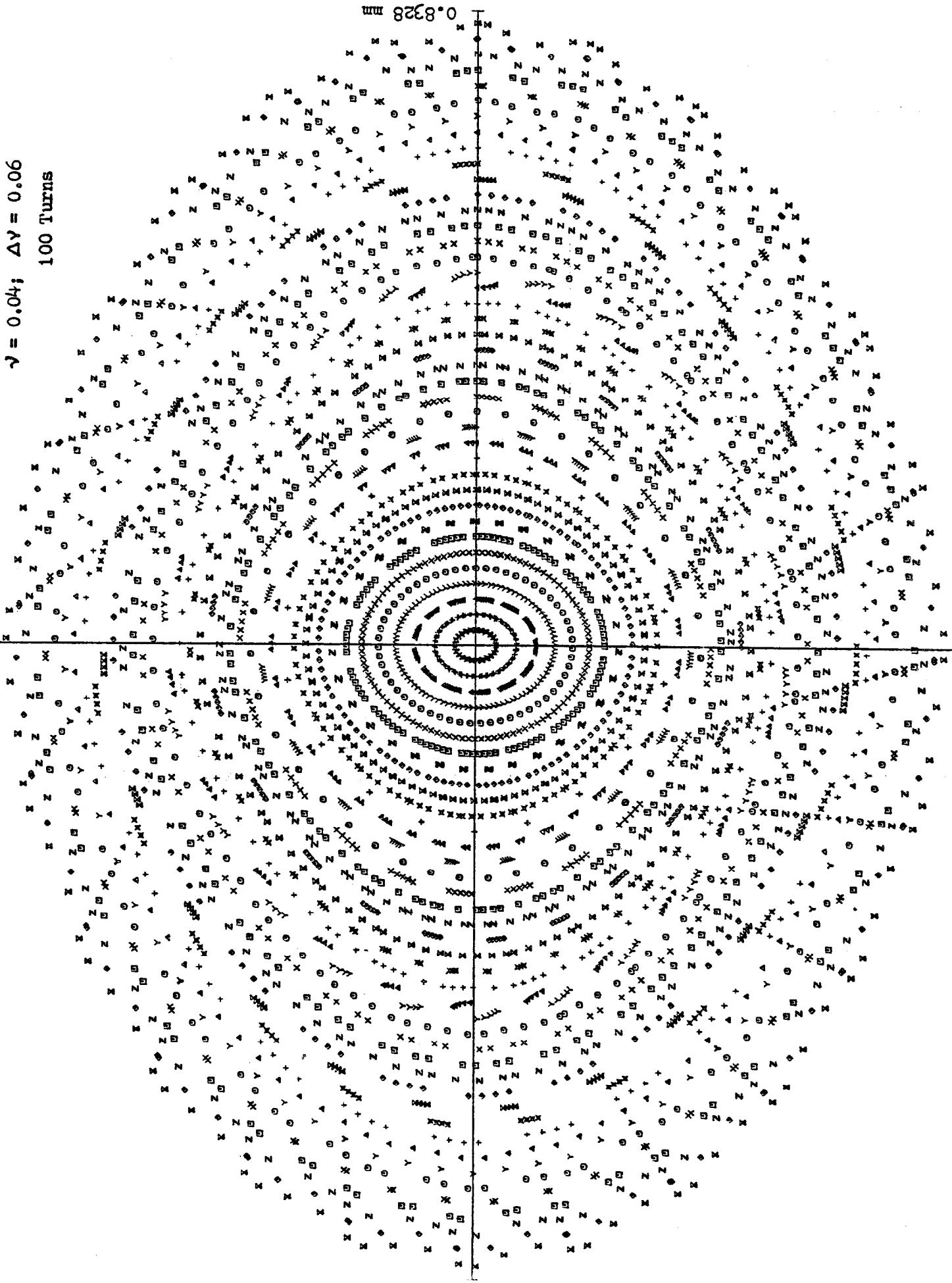
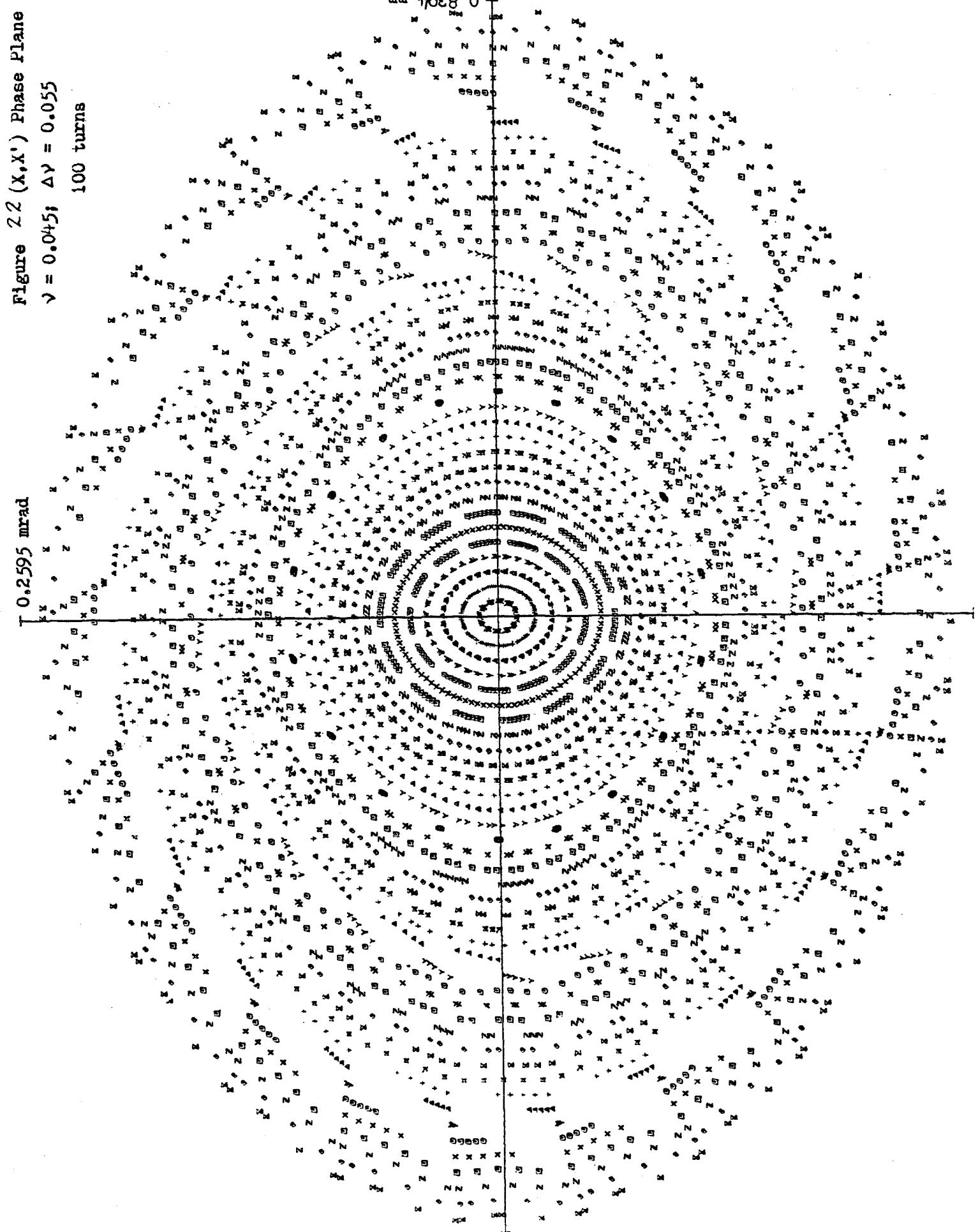


Figure 22
TM-1054



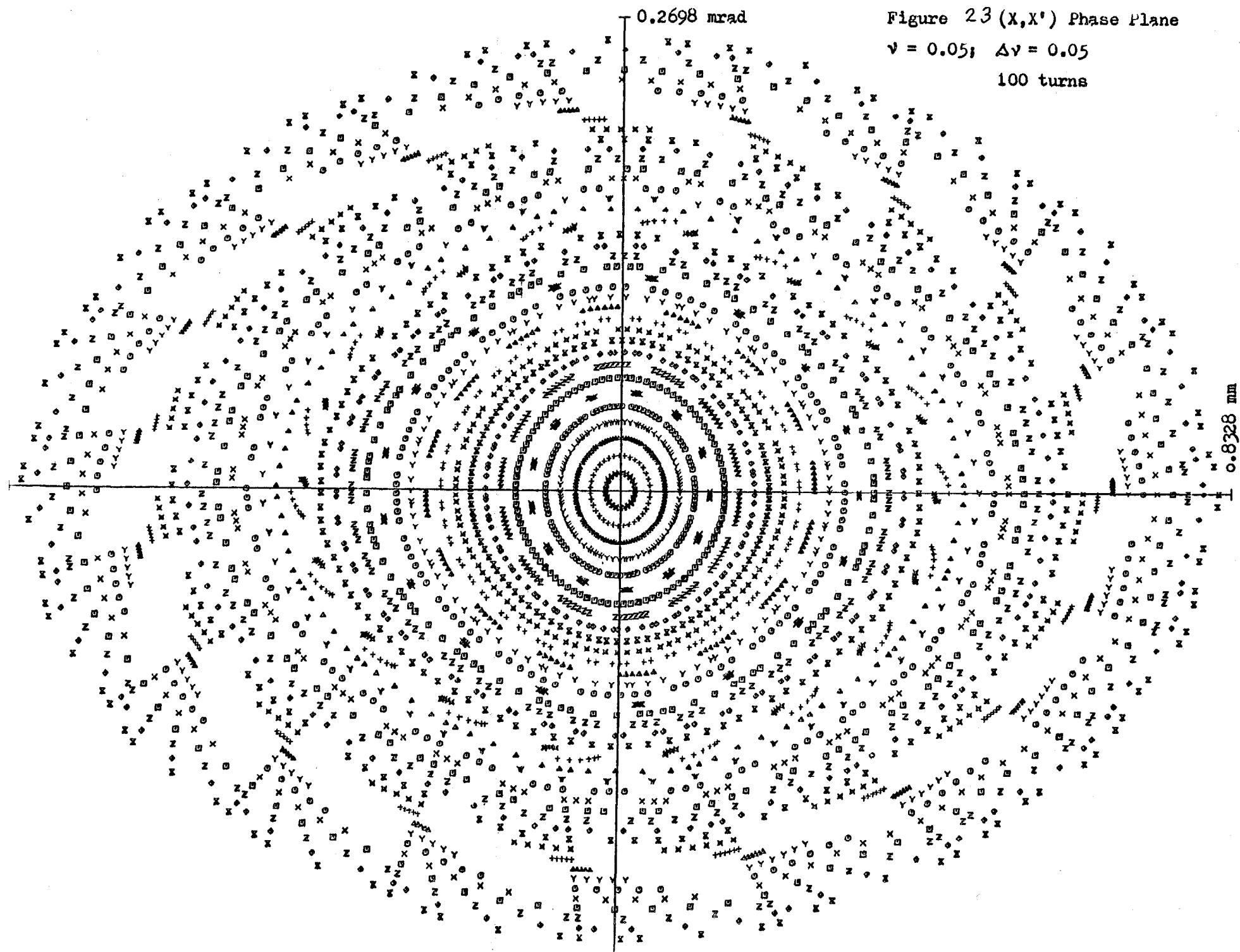
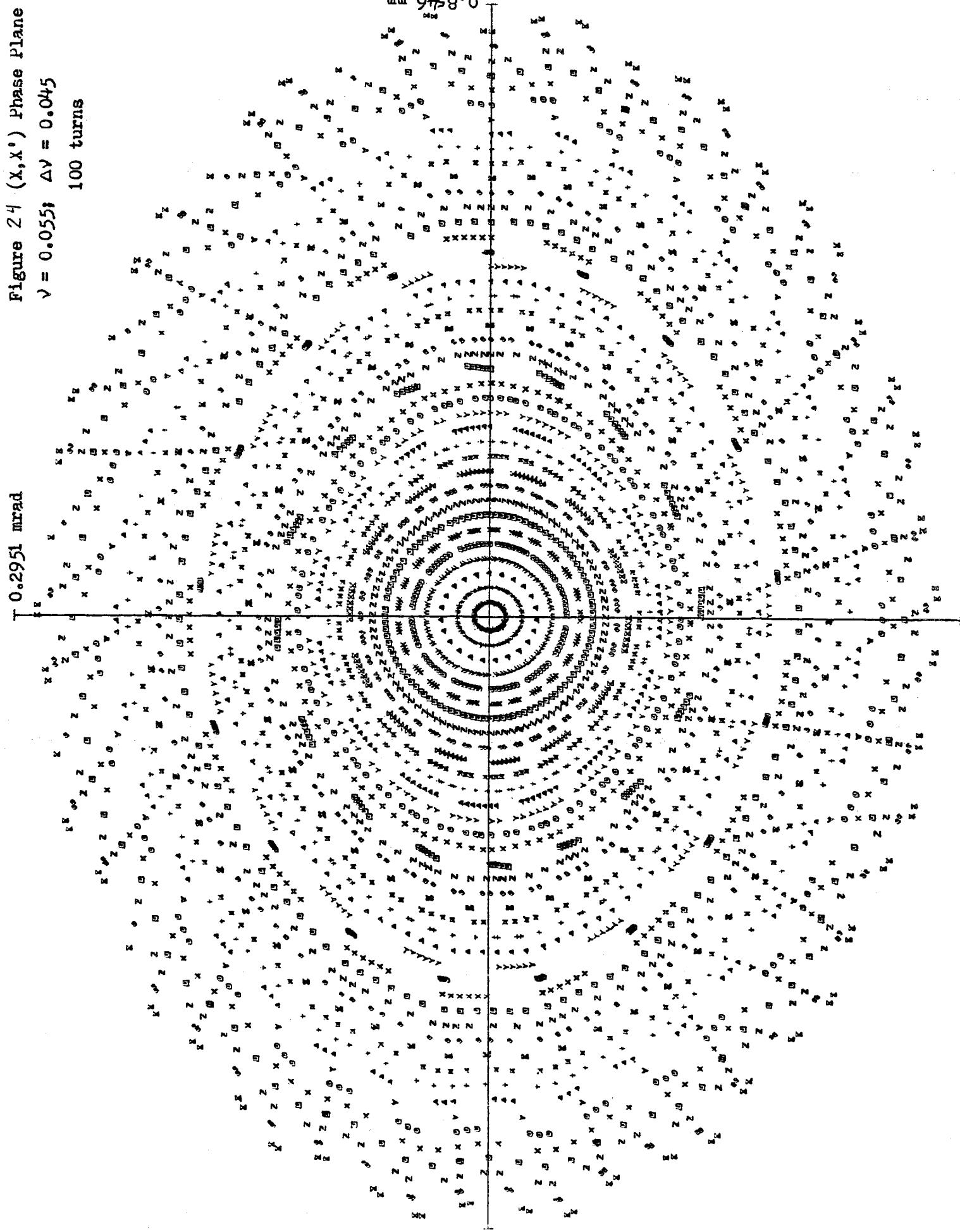


Figure 23
TM-1054



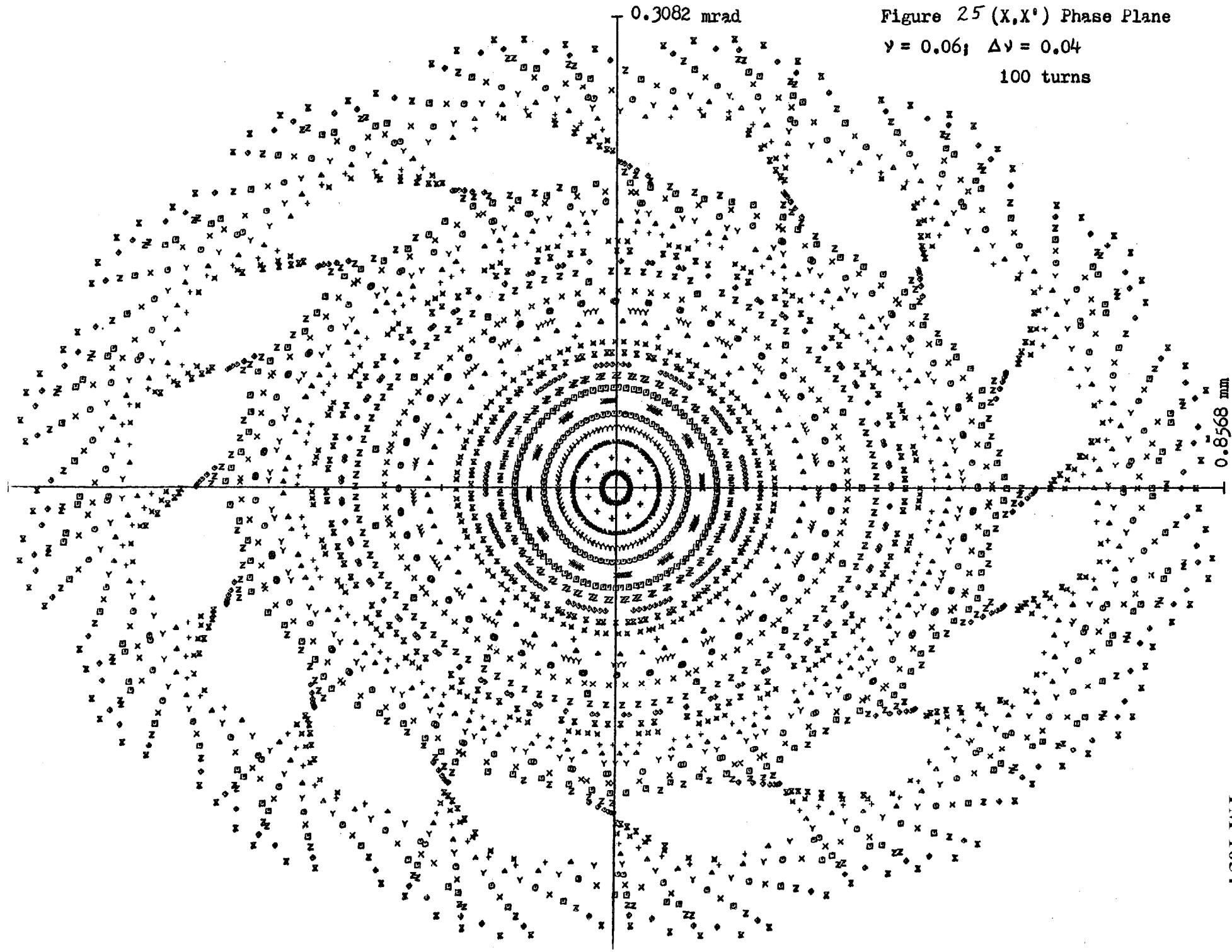


Figure 25 (X, X') Phase Plane
 $y = 0.06$; $\Delta y = 0.04$
 100 turns

Figure 25

Figure 26
TM-1054

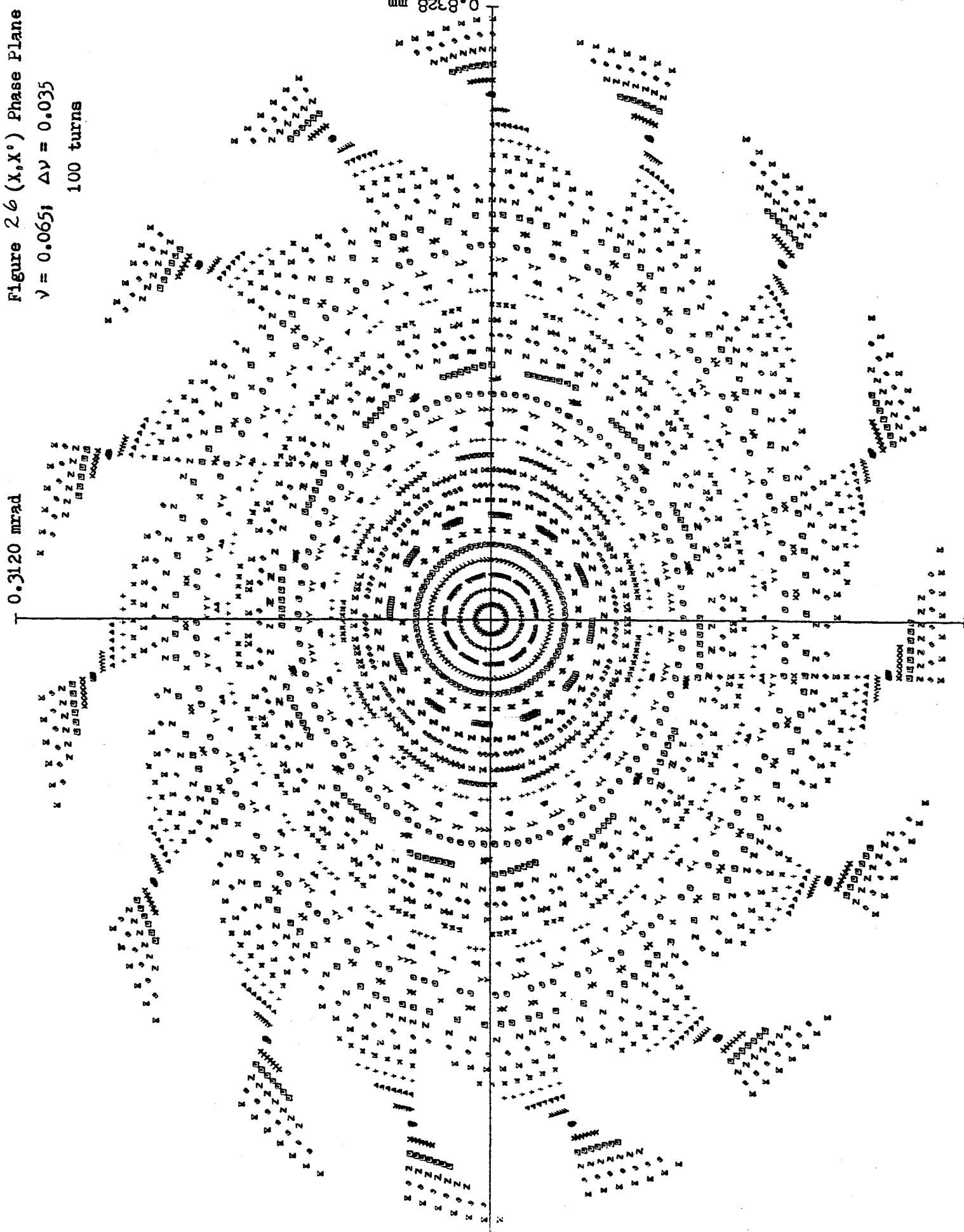
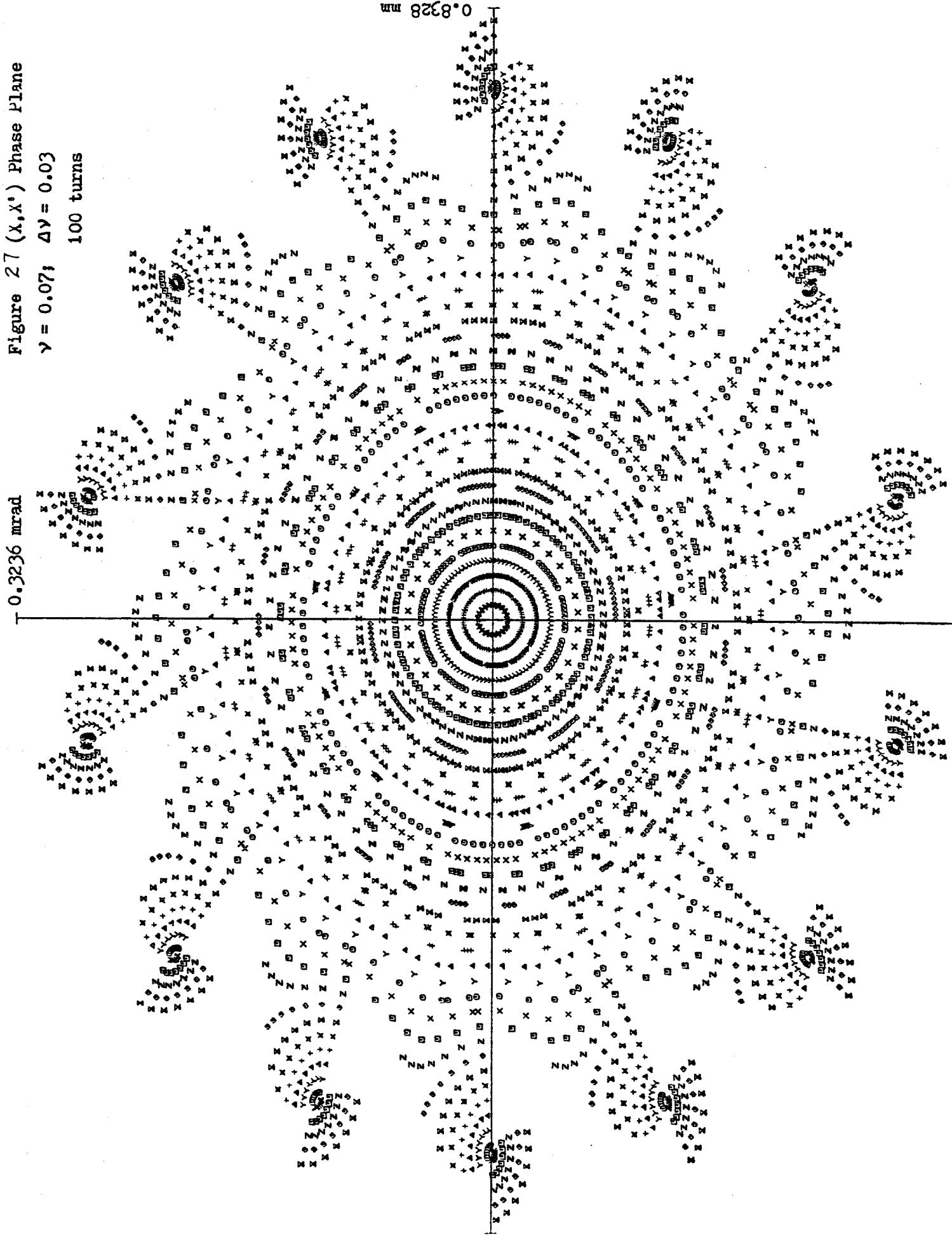


Figure 27 (X, X') Phase Plane
 $\gamma = 0.07; \Delta\gamma = 0.03$
100 turns



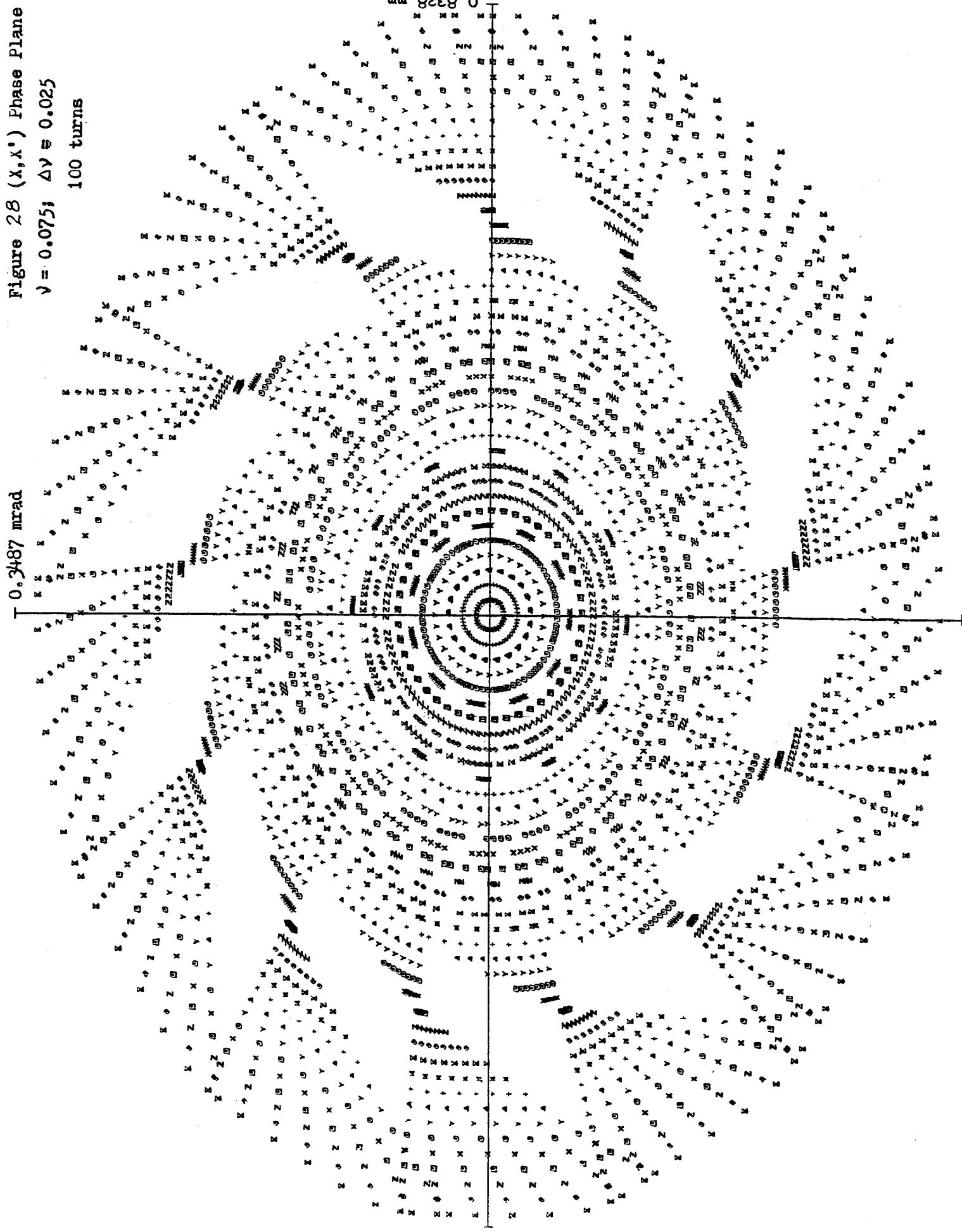


Figure 29 (X, X') Phase Plane

$V = 0.08$; $\Delta V = 0.02$
100 turns

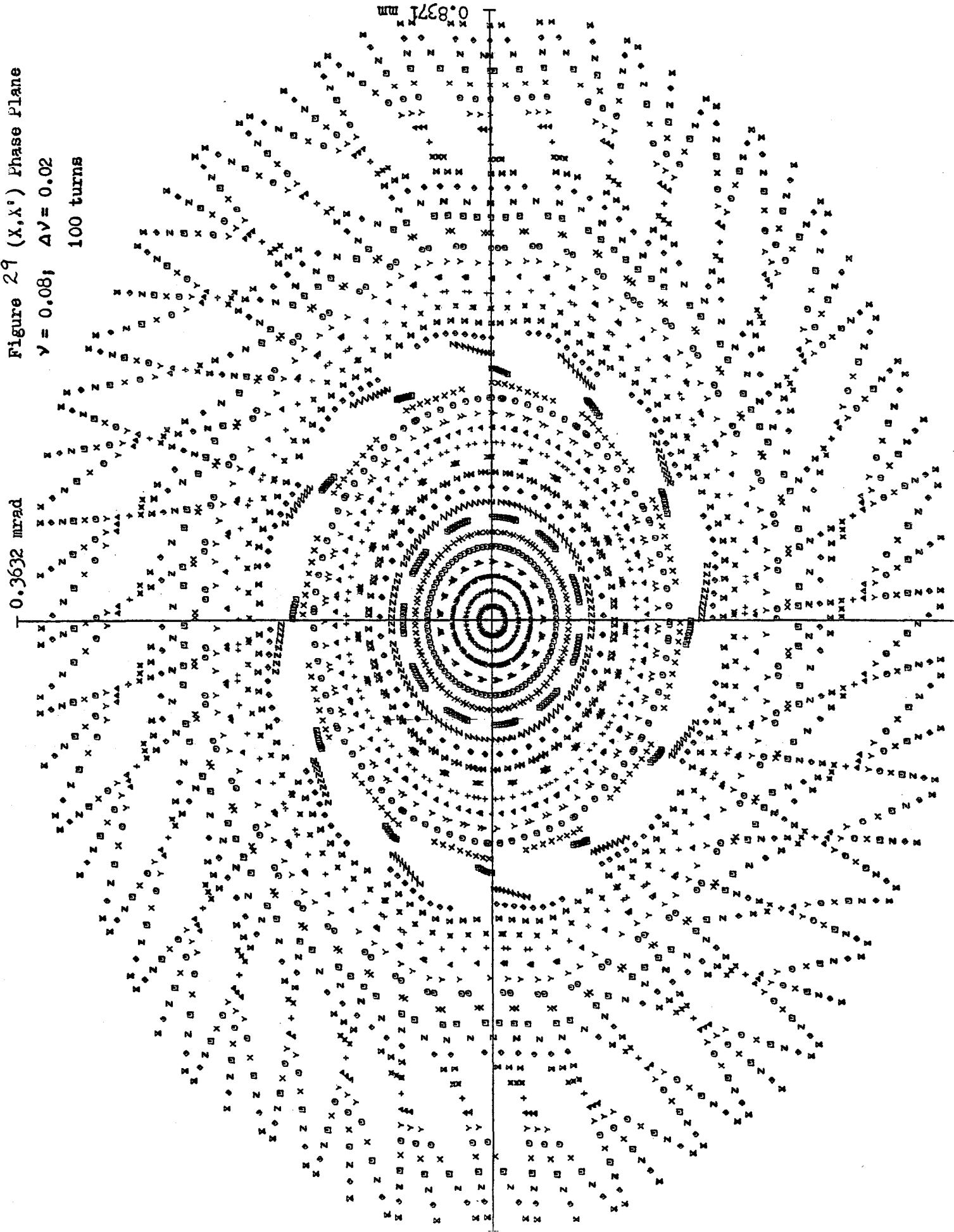


Figure 30
TM-1054

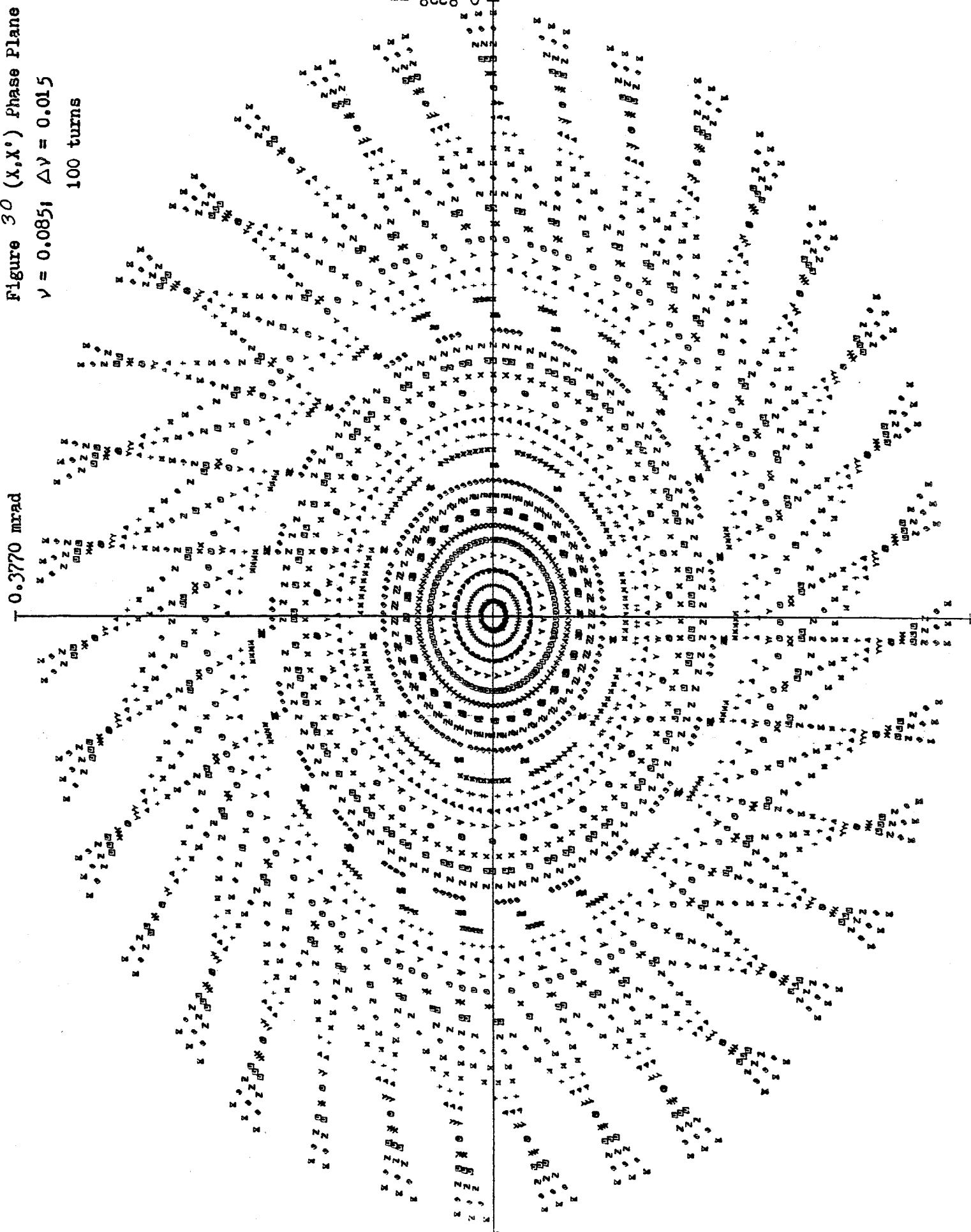


Figure 31 (x, x') Phase Plane
 $\gamma = 0.09; \Delta\gamma = 0.01; x_0' = 0$
 $x_0 = 0.25\sigma, 0.5\sigma, \dots, 10\sigma$
 $\sigma = 0.08165 \text{ mm}; 100 \text{ turns}$

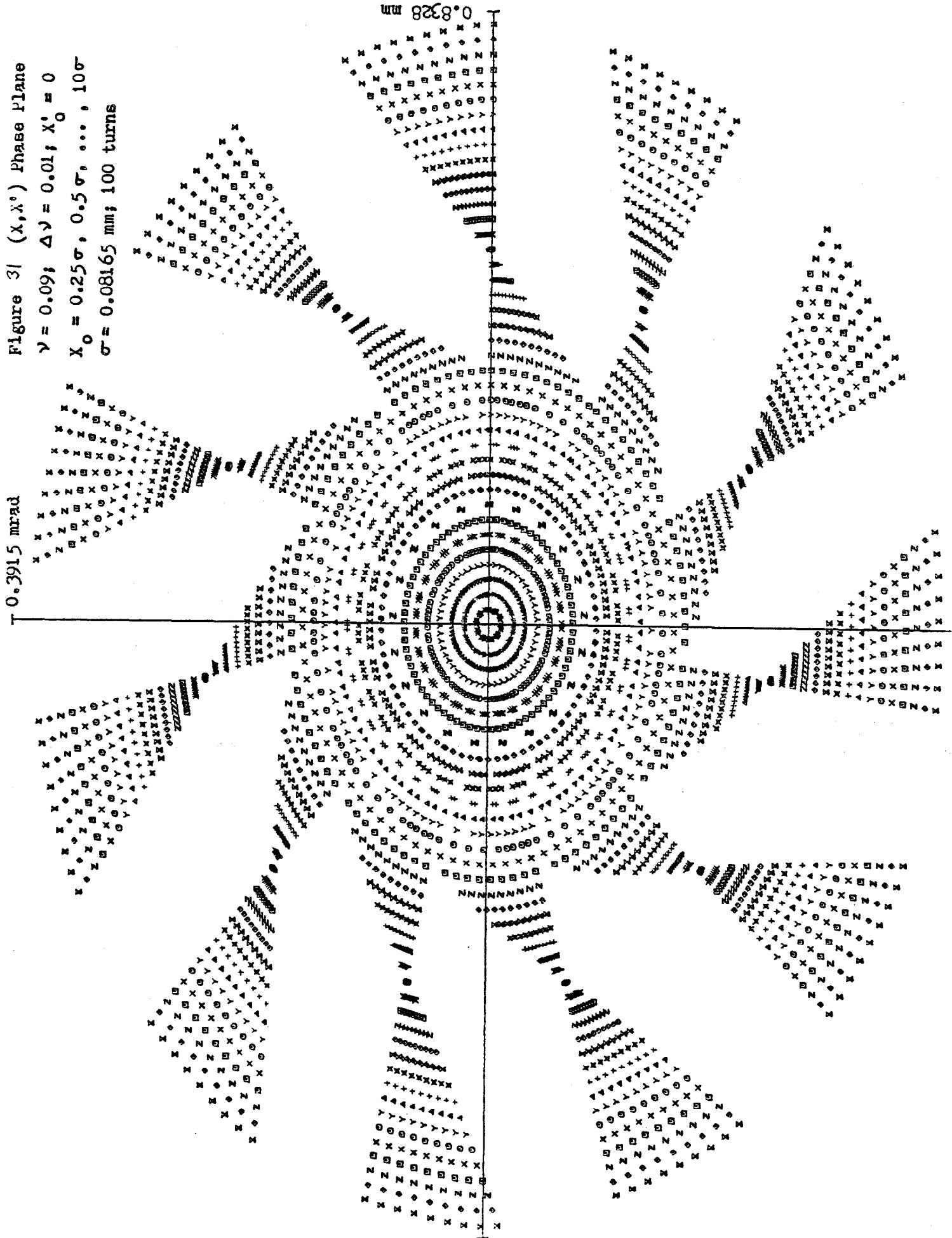


Figure 32
TM-1054

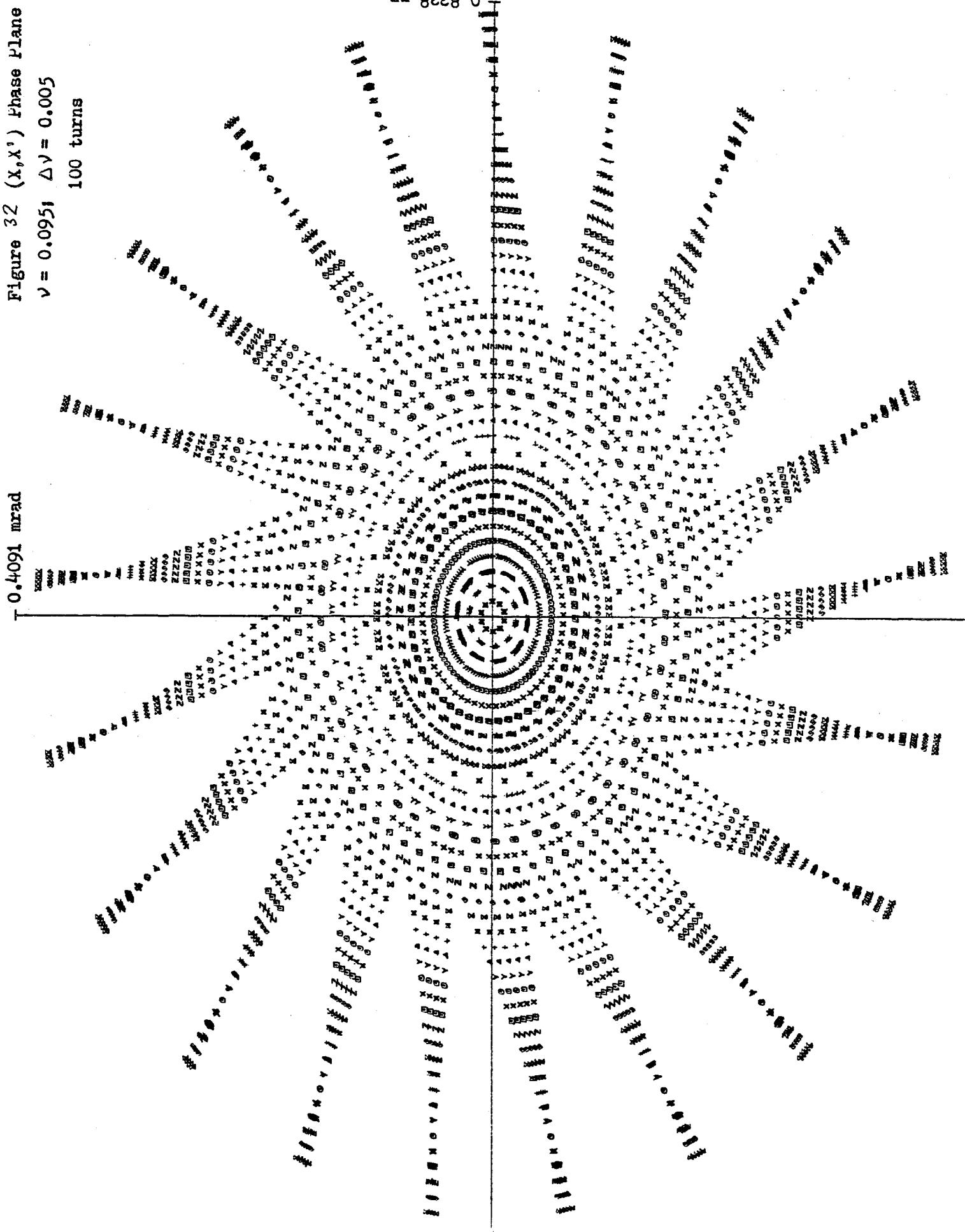


Figure 33
TM-1054

Figure 33 (x, x') Phase Space
 $\nu = 0.10; \Delta y = 0.00; x'_0 = 0$
 $x_0 = 0.25\sigma, 0.5\sigma, \dots, 10\sigma$
 $\sigma = 0.08165 \text{ mm}; 100 \text{ turns}$

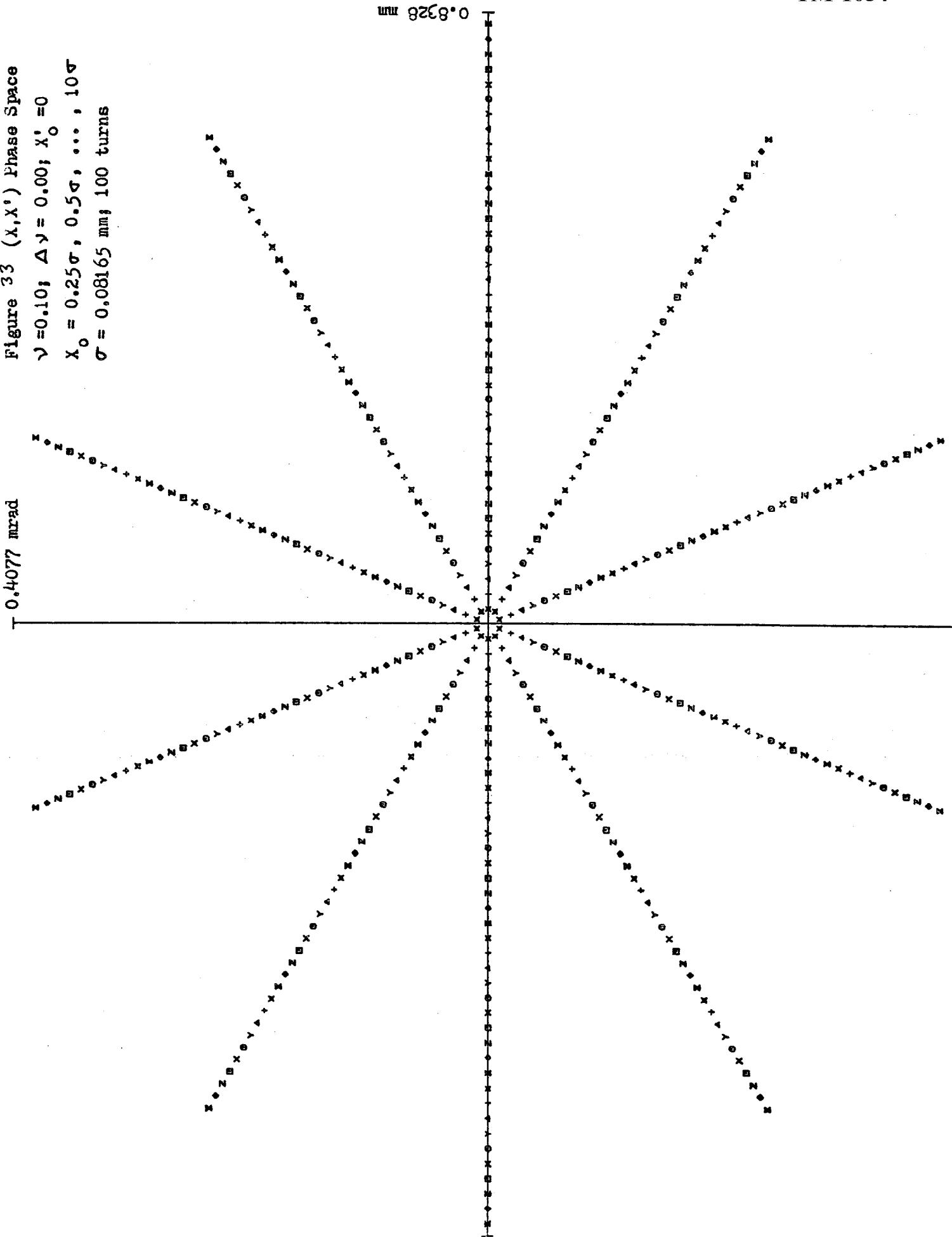


Figure 34 (X, X') Phase Plane

$\gamma = 0.05; \Delta\gamma = 0.10$
100 turns

0.2240 mrad

T

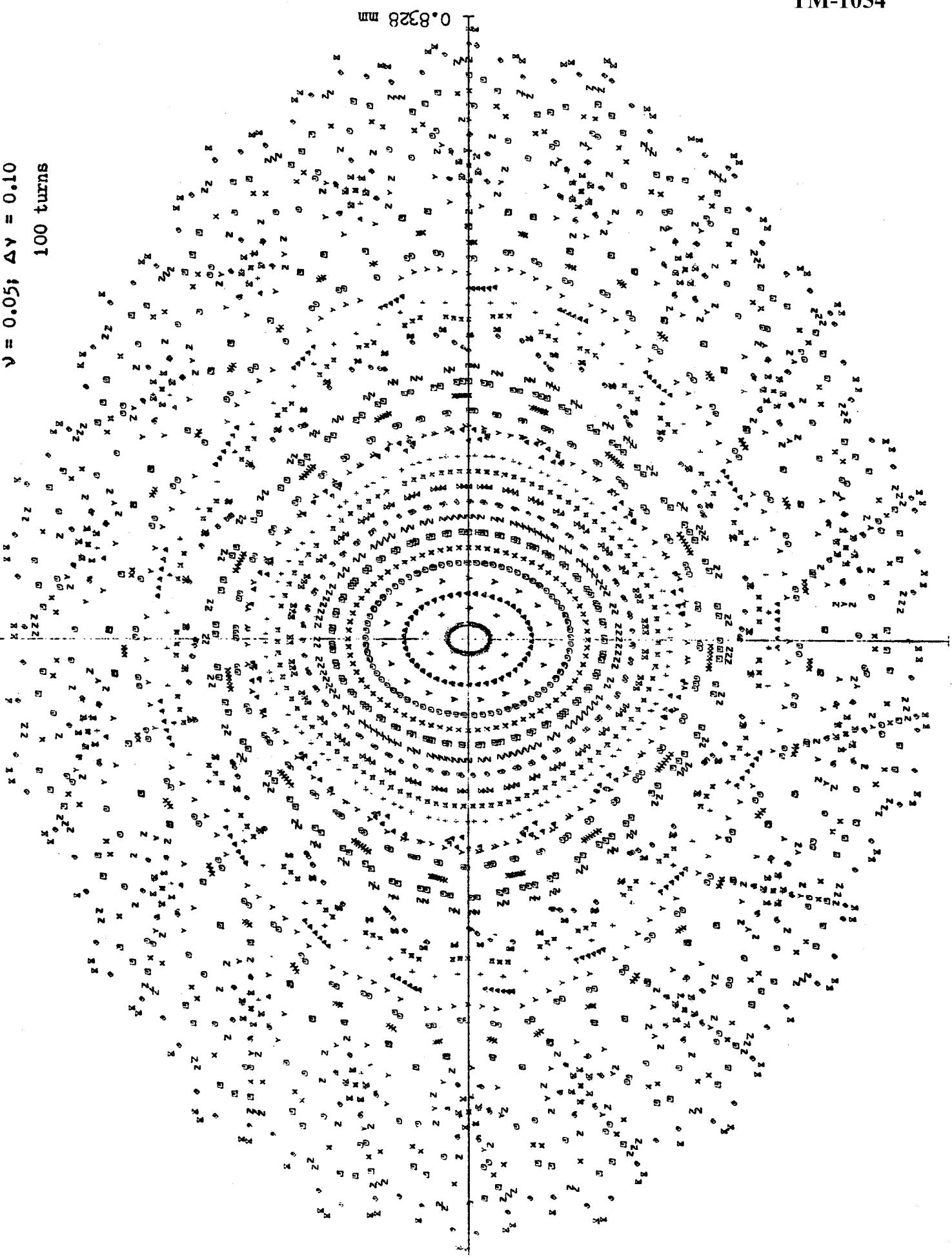


Figure 35
TM-1054

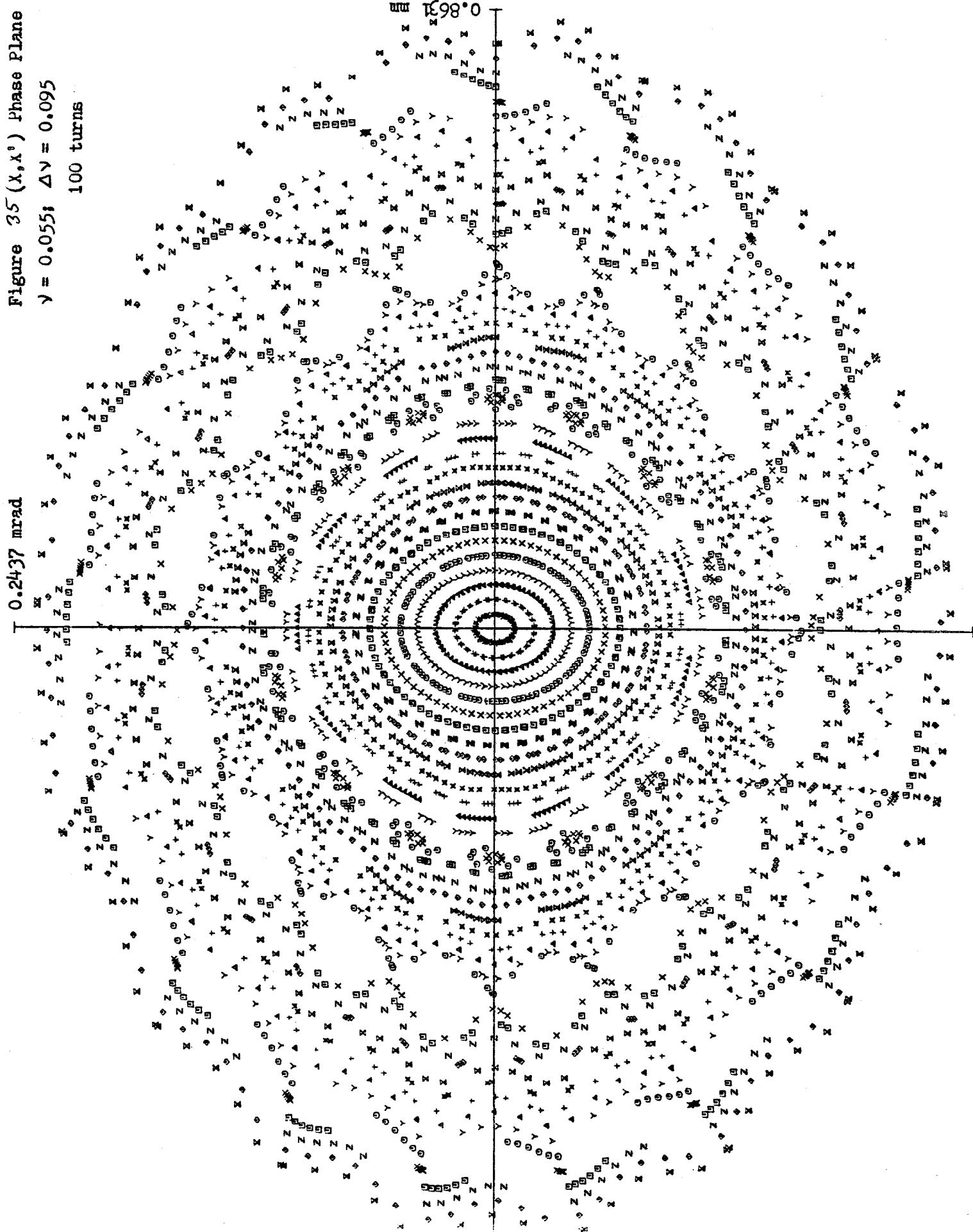


Figure 36

TM-1054

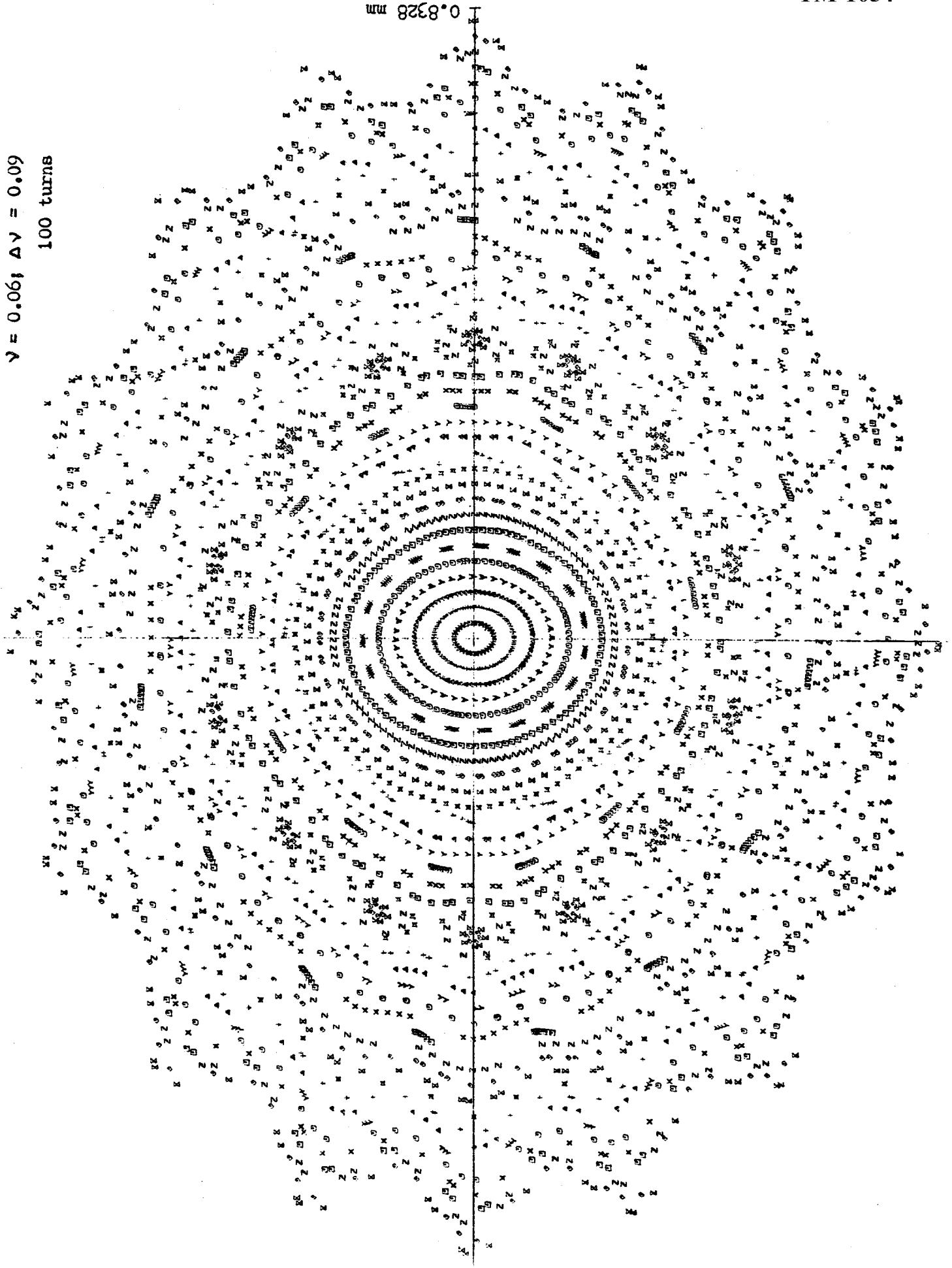
0.2464 mrad Figure 36 (X, X') Phase Plane

Figure 37

TM-1054

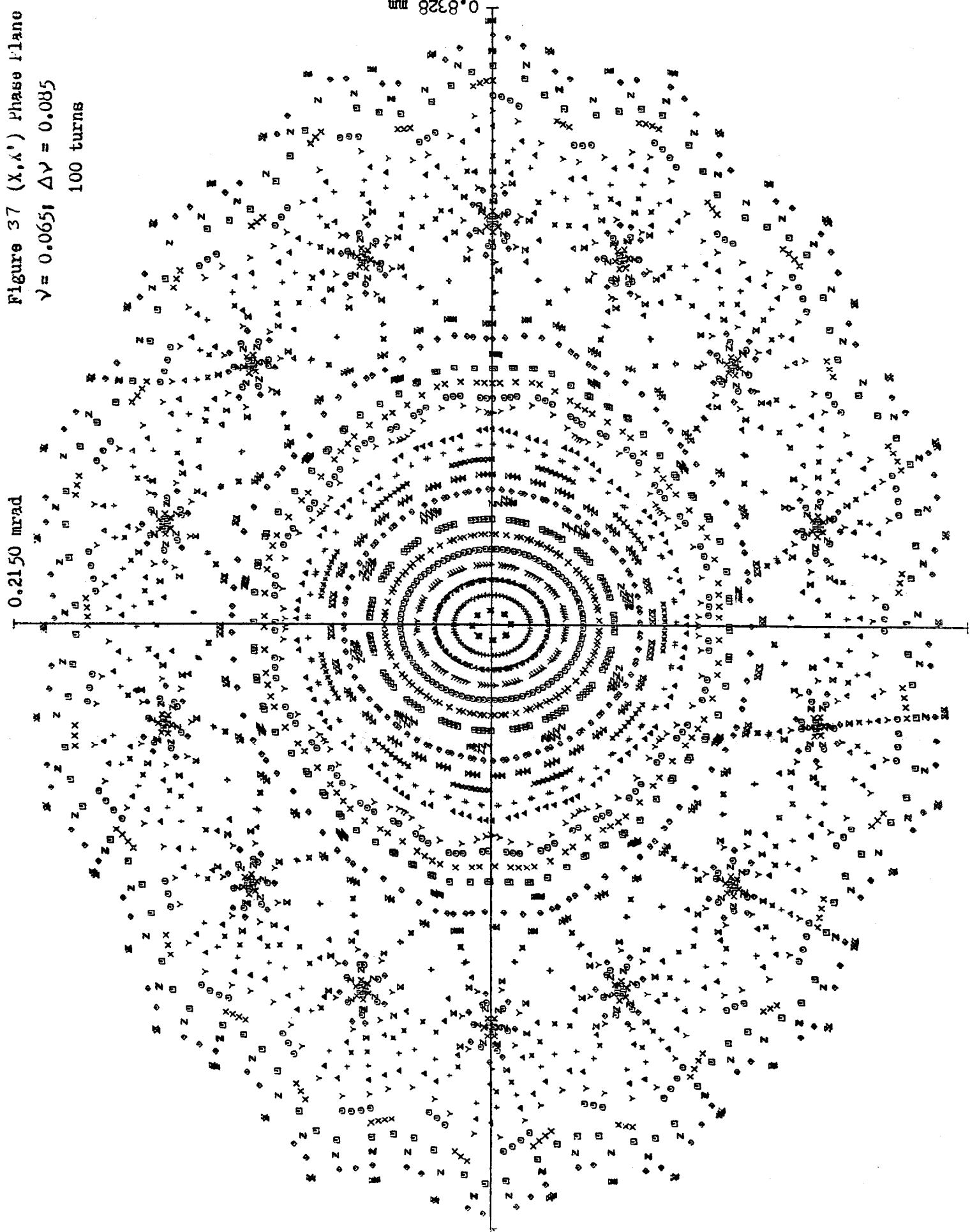
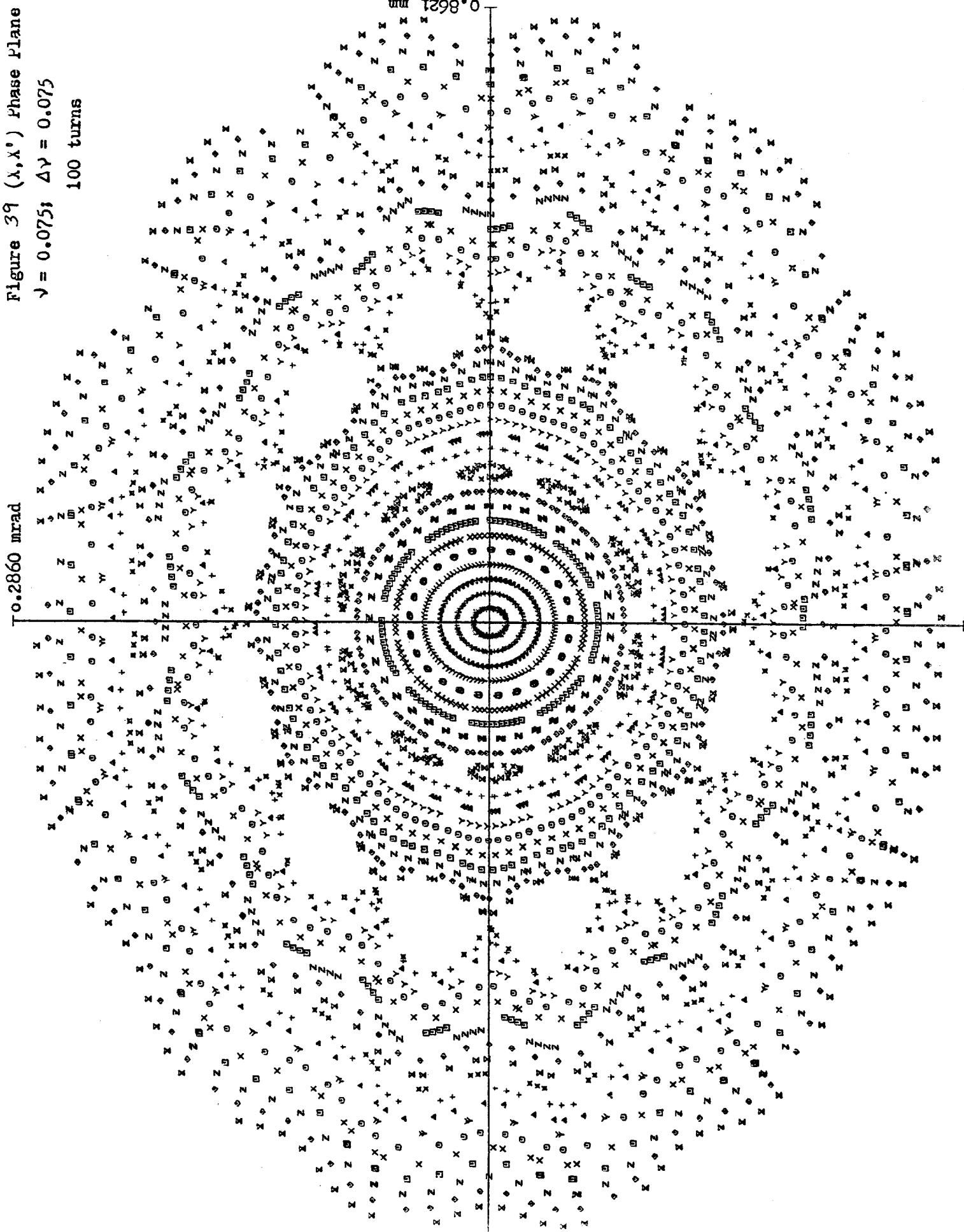


Figure 38 (X, X') Phase Plane $\gamma = 0.07; \Delta\gamma = 0.08$

100 turns

0.3189 mrad





0.3302 mrad

Figure 40 (X, X') Phase Plane

$\gamma = 0.08$; $\Delta \gamma = 0.07$ 100 turns

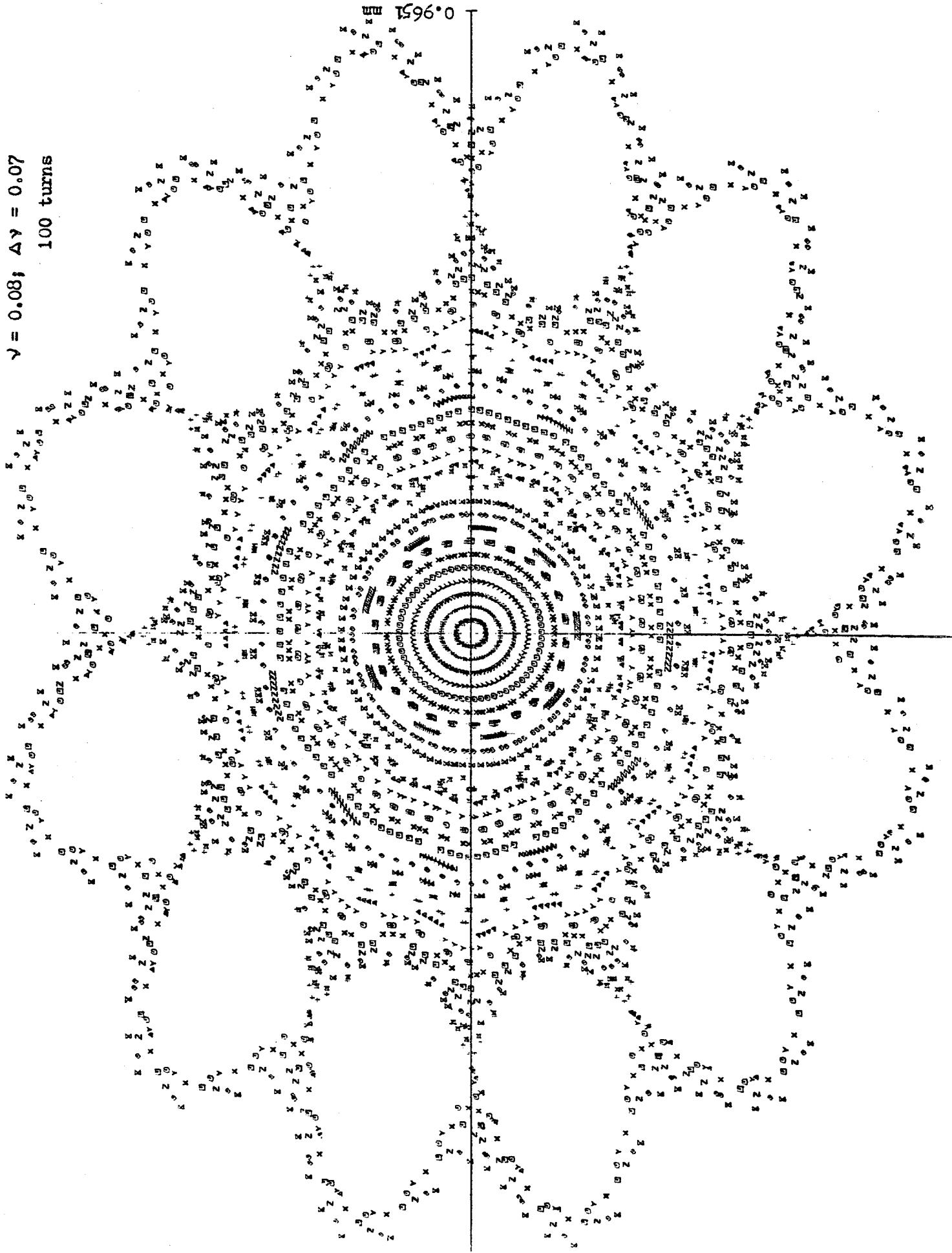


Figure 40

TM-1054

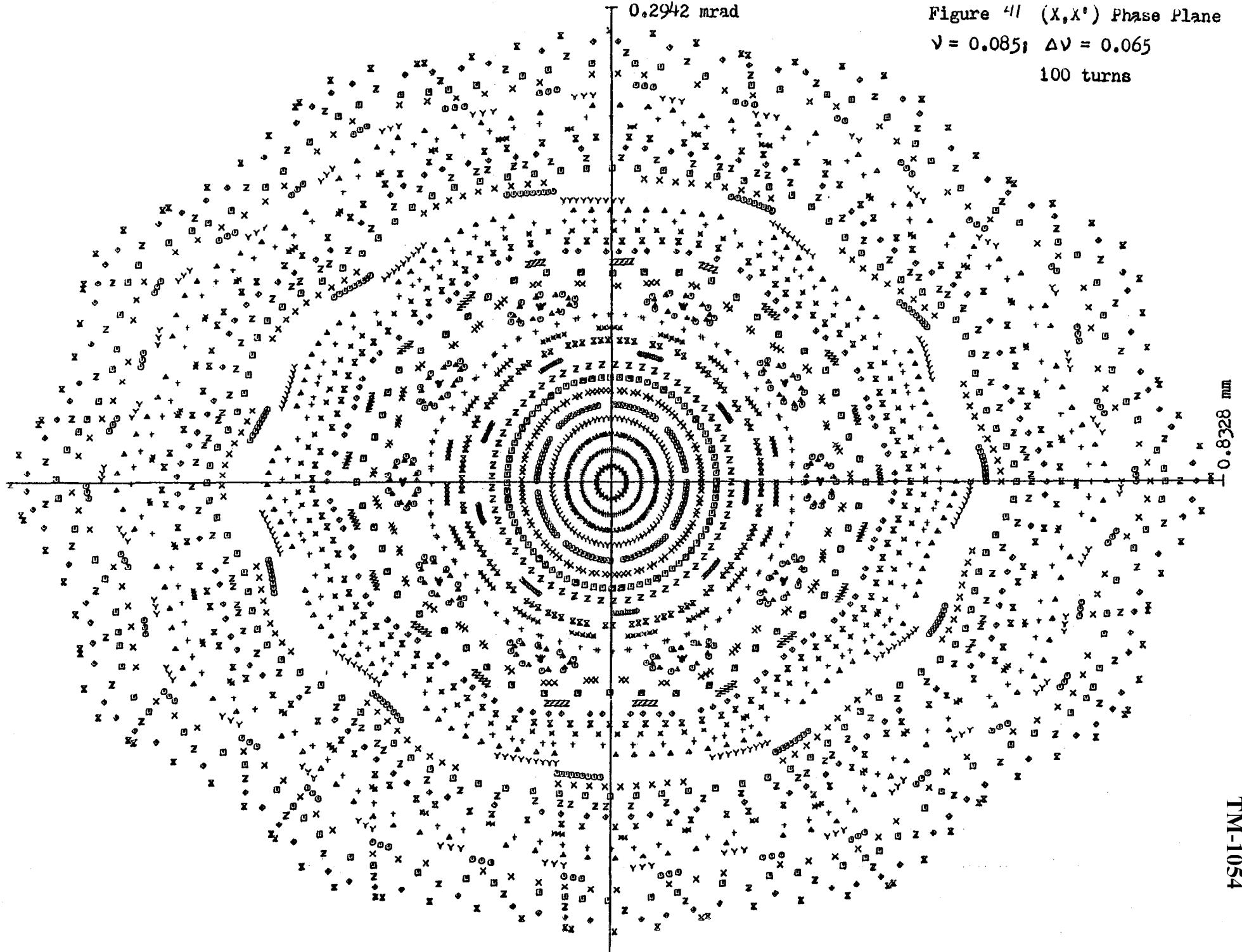


Figure 41

TM-1054

Figure 42
TM-1054

Figure 42 (X,X⁰) Phase Plane

0.3024 mrad

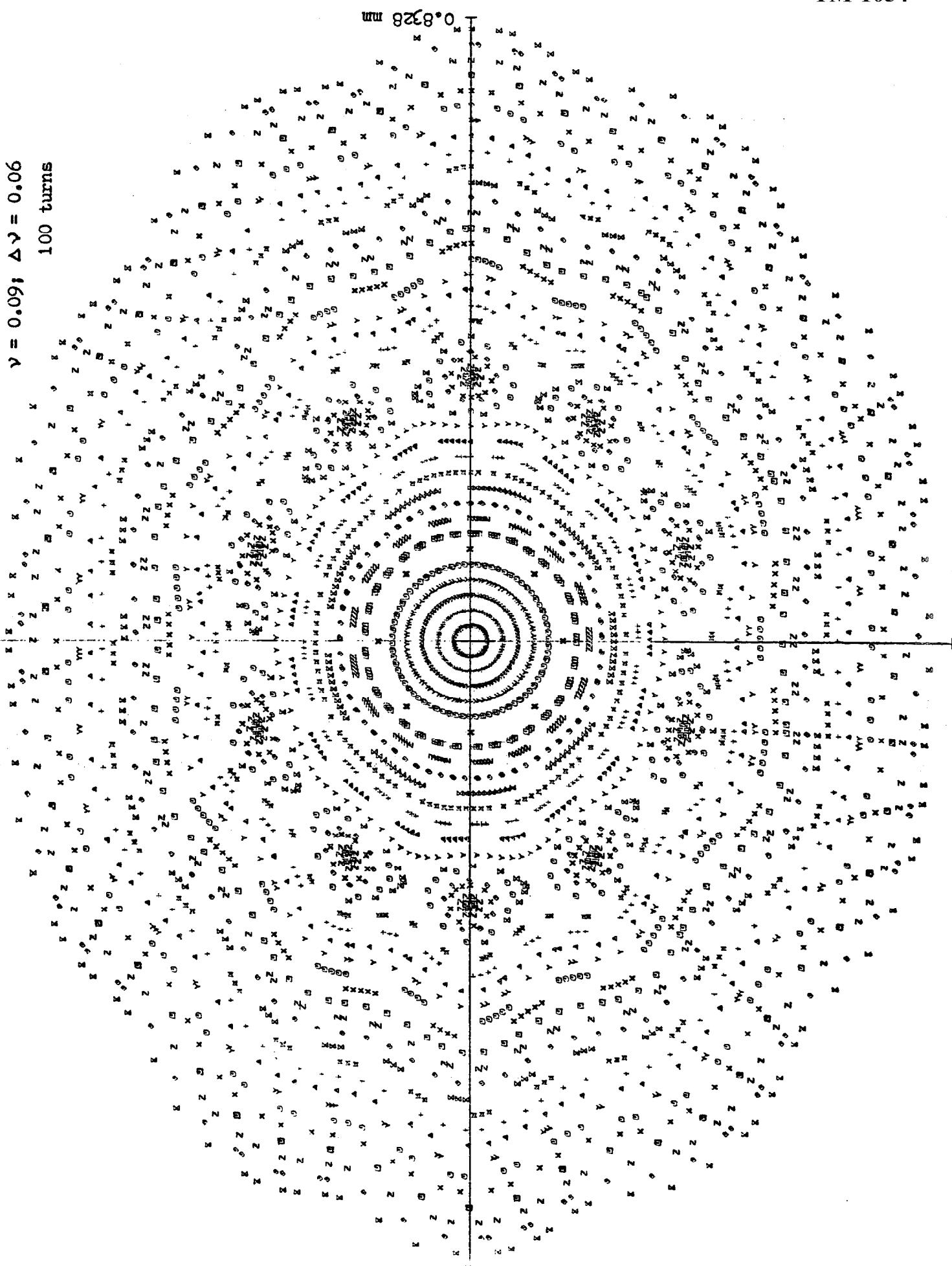


Figure 43

TM-1054

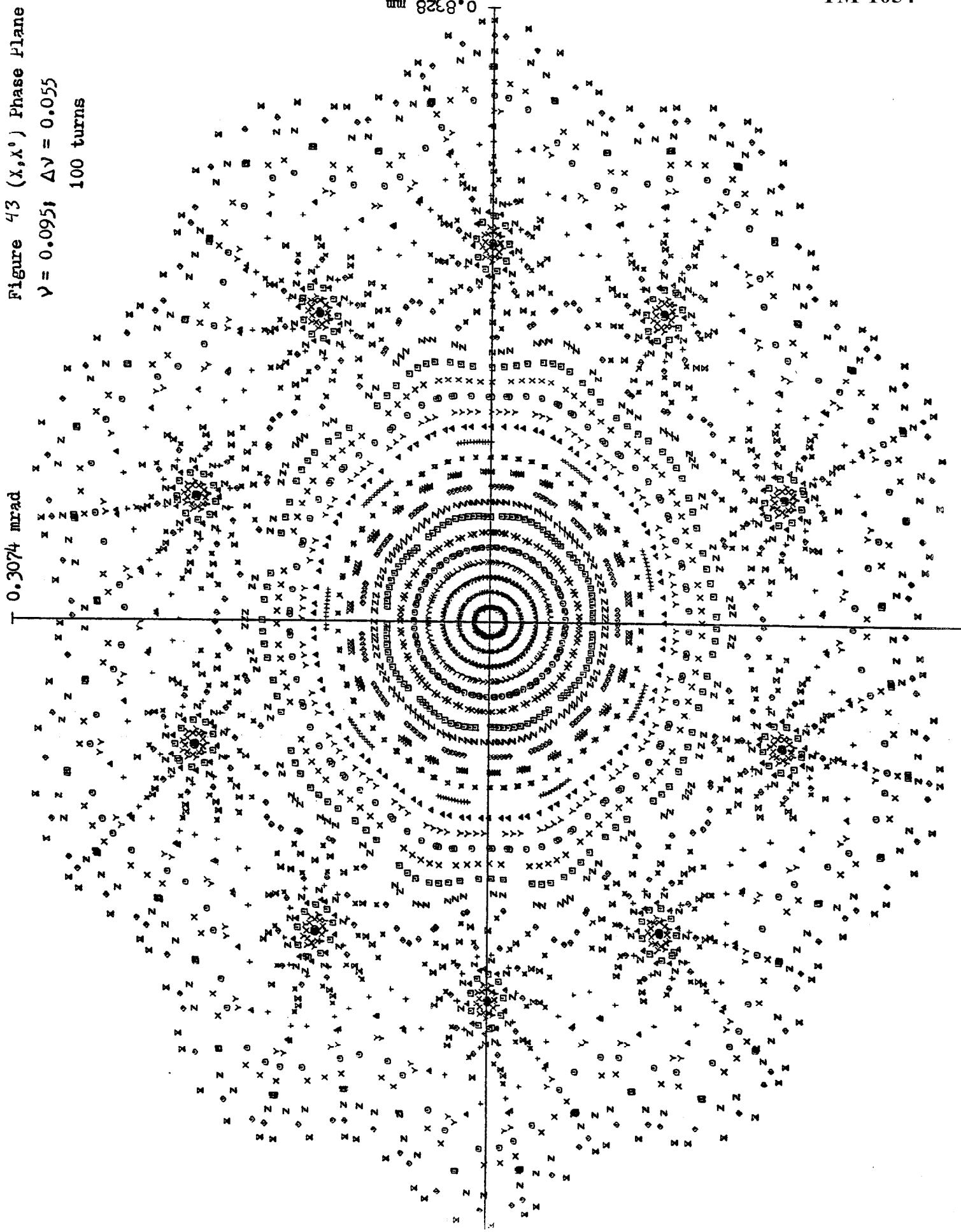


Figure 44 (X, X') Phase Plane $\nu = 0.10; \Delta\nu = 0.05$

100 turns

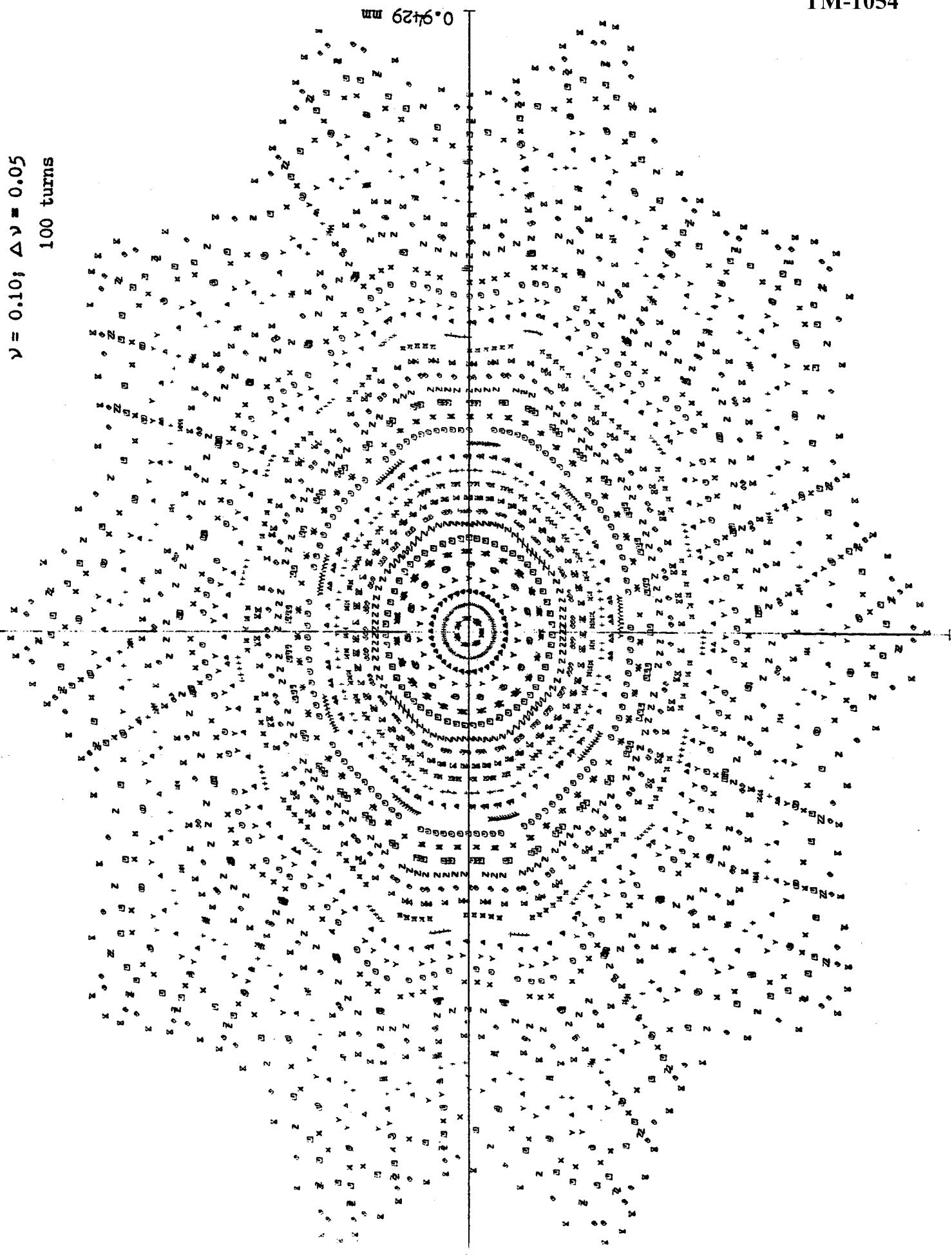
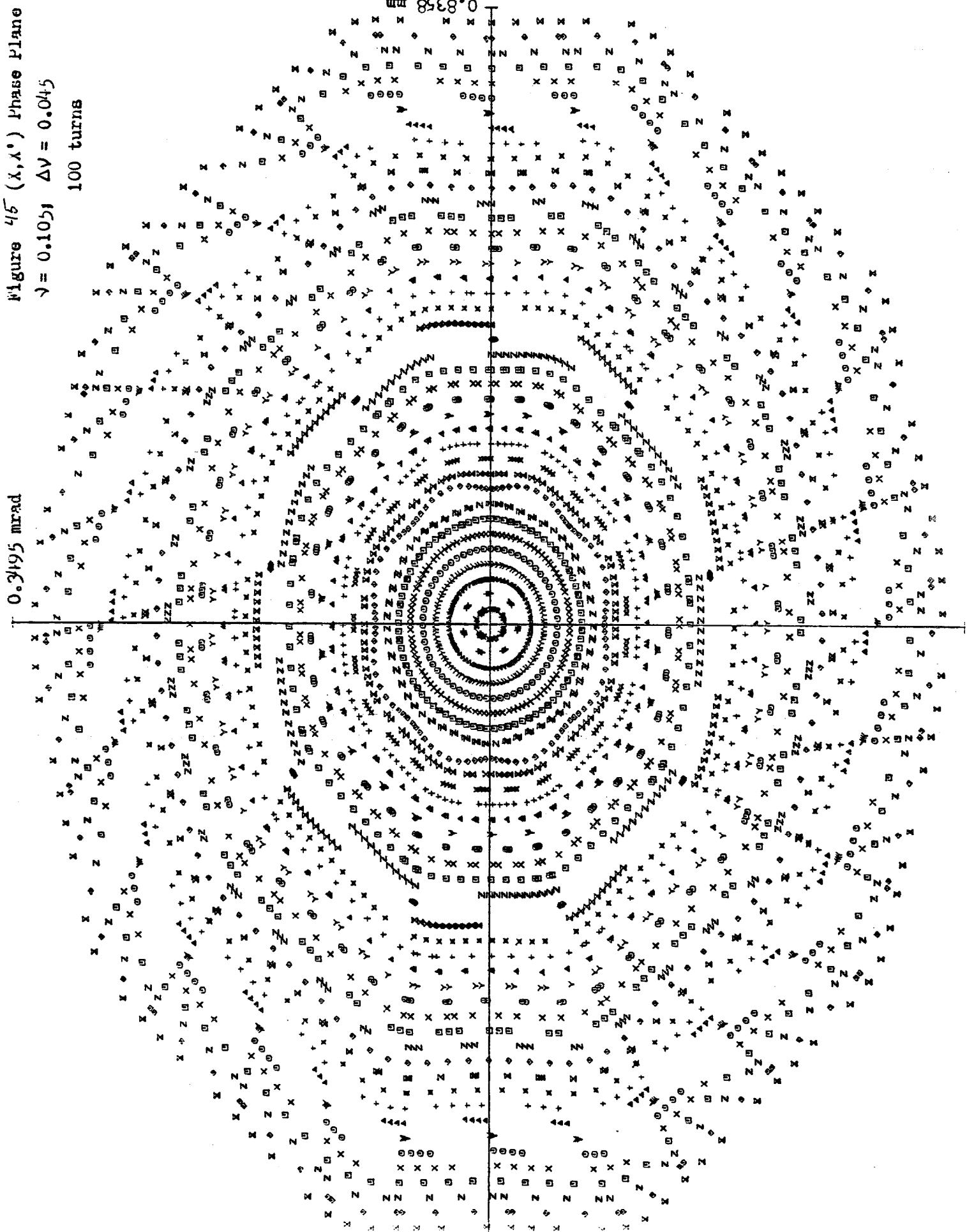


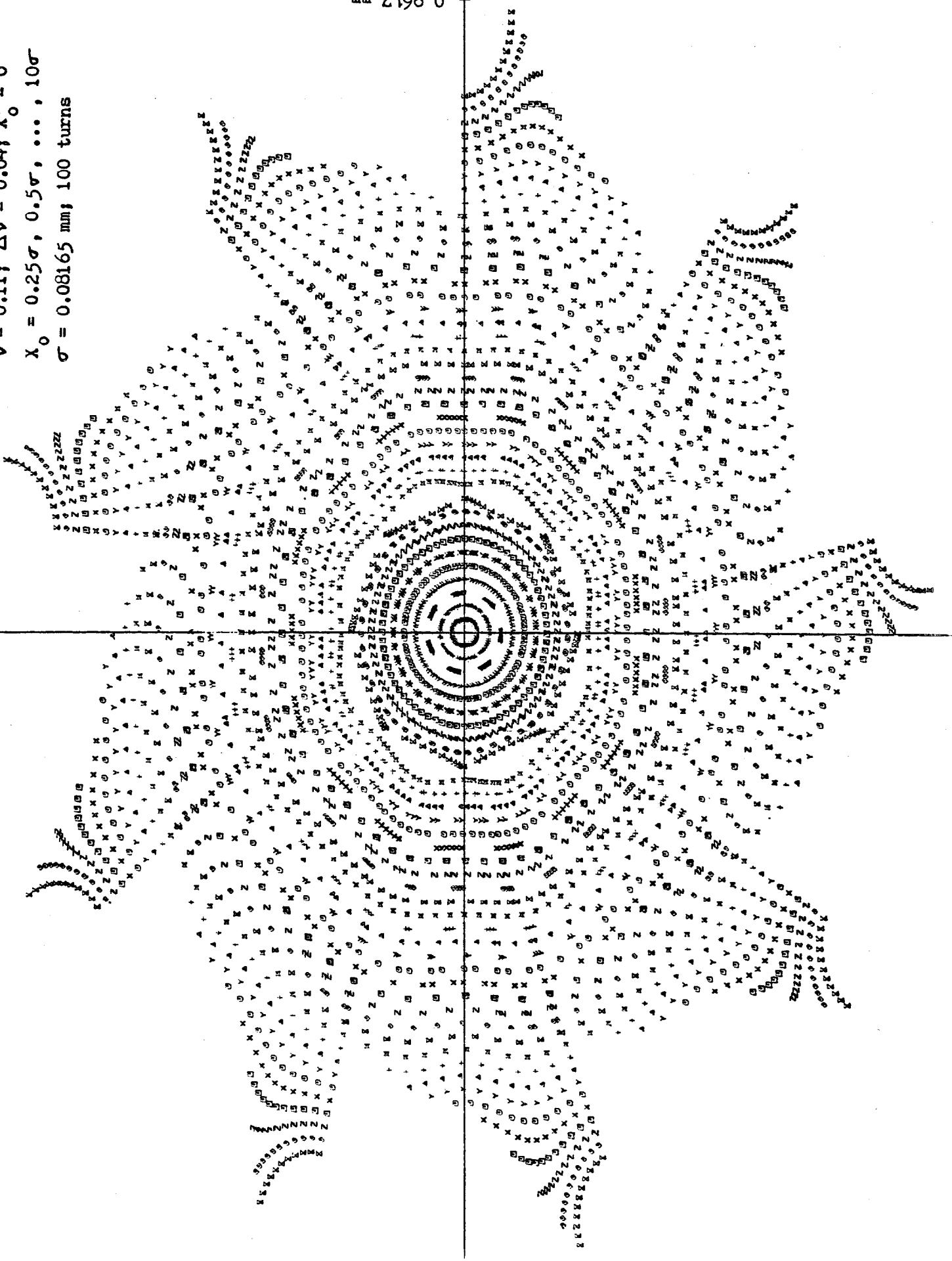
Figure 45

TM-1054



0.1967 mm

0.4023 mrad

Figure 46 (X, X') Phase Plane
 $\nu = 0.11; \Delta\nu = 0.04; X_0^i = 0$
 $X_0 = 0.25\sigma, 0.5\sigma, \dots, 10\sigma$
 $\sigma = 0.08165 \text{ mm}; 100 \text{ turns}$


TM-1054

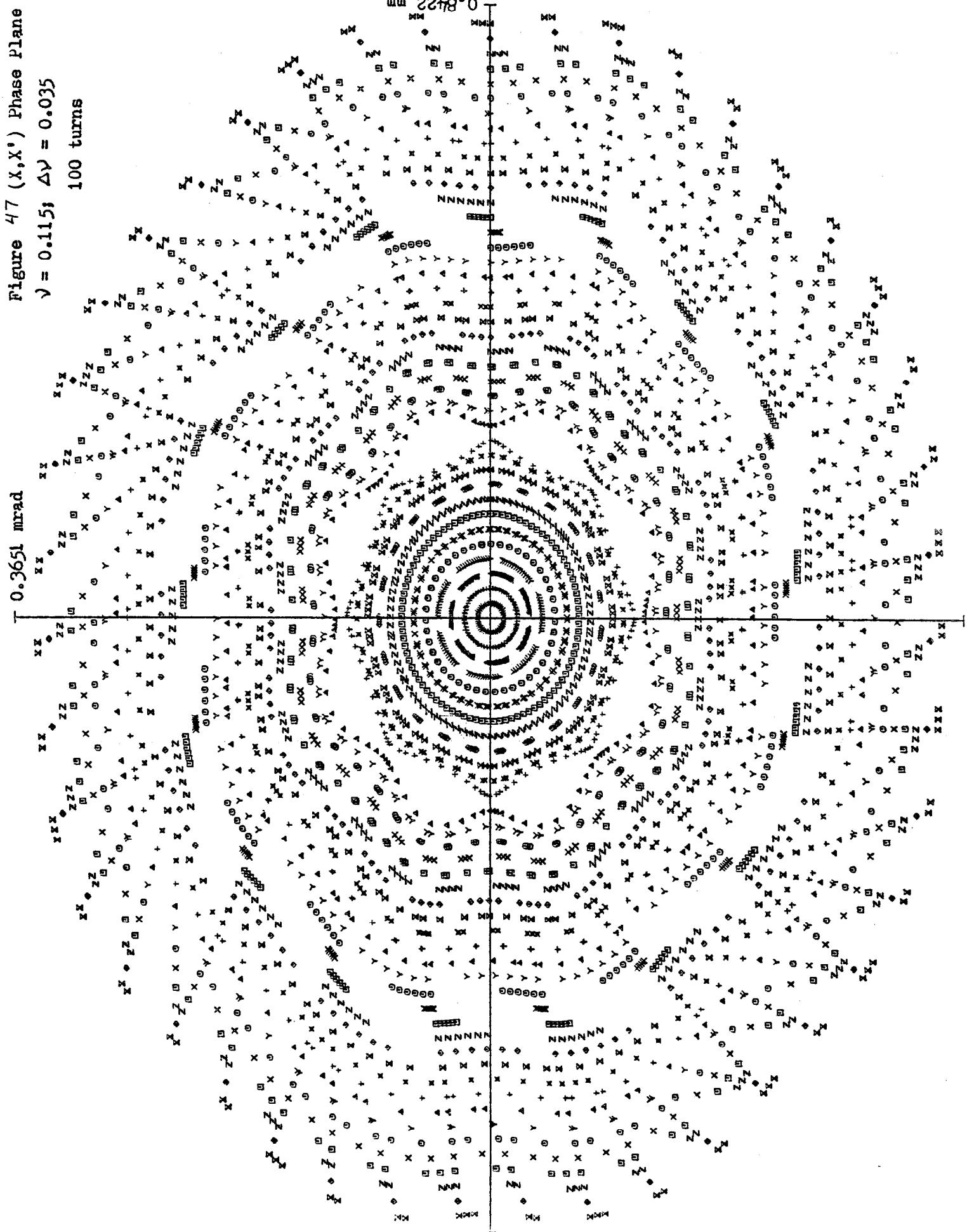


Figure 48
TM-1054

Figure 4B (X, X') Phase Plane

$\gamma = 0.12; \Delta\psi = 0.03$

100 turns

0.3778 mrad

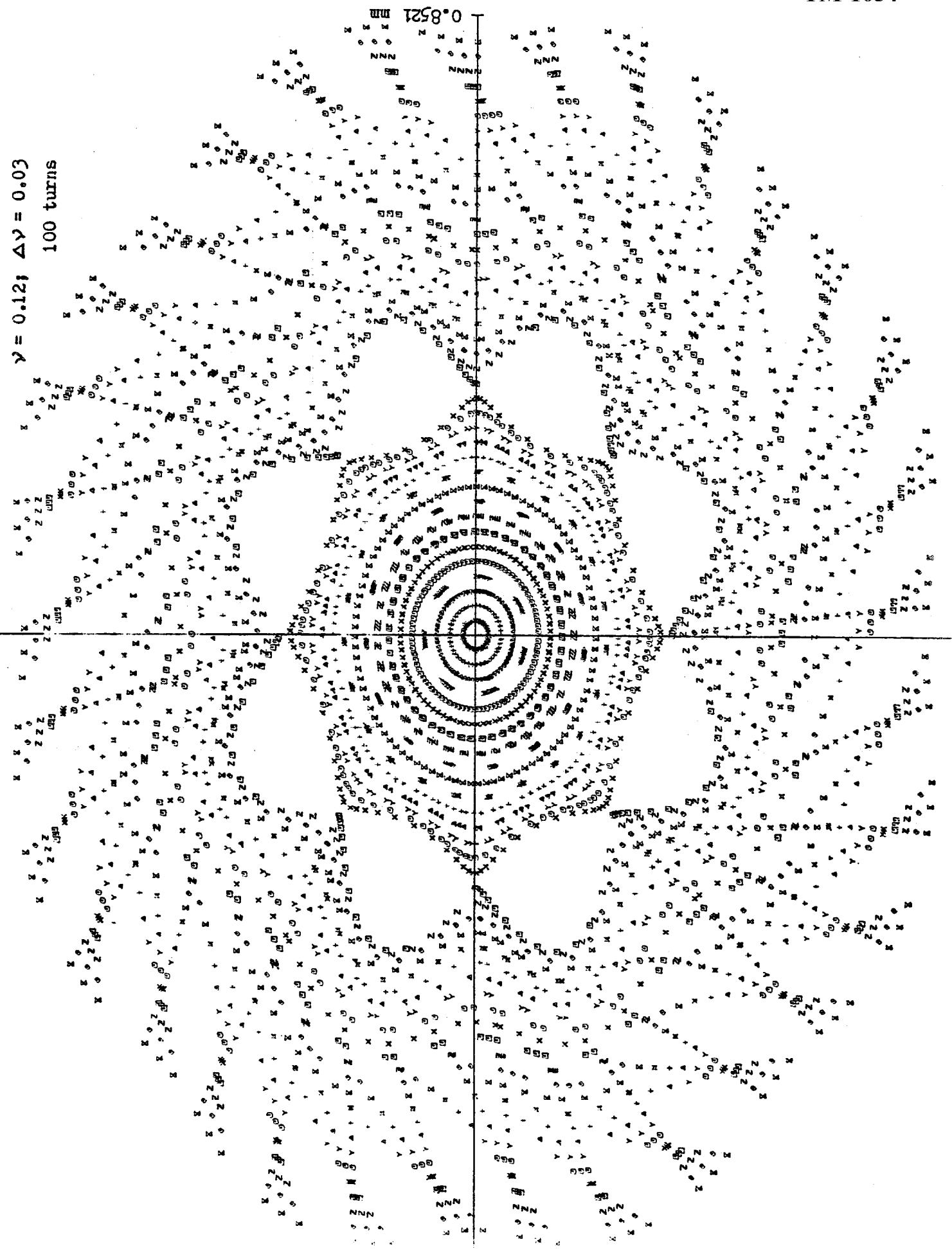


Figure 49
TM-1054

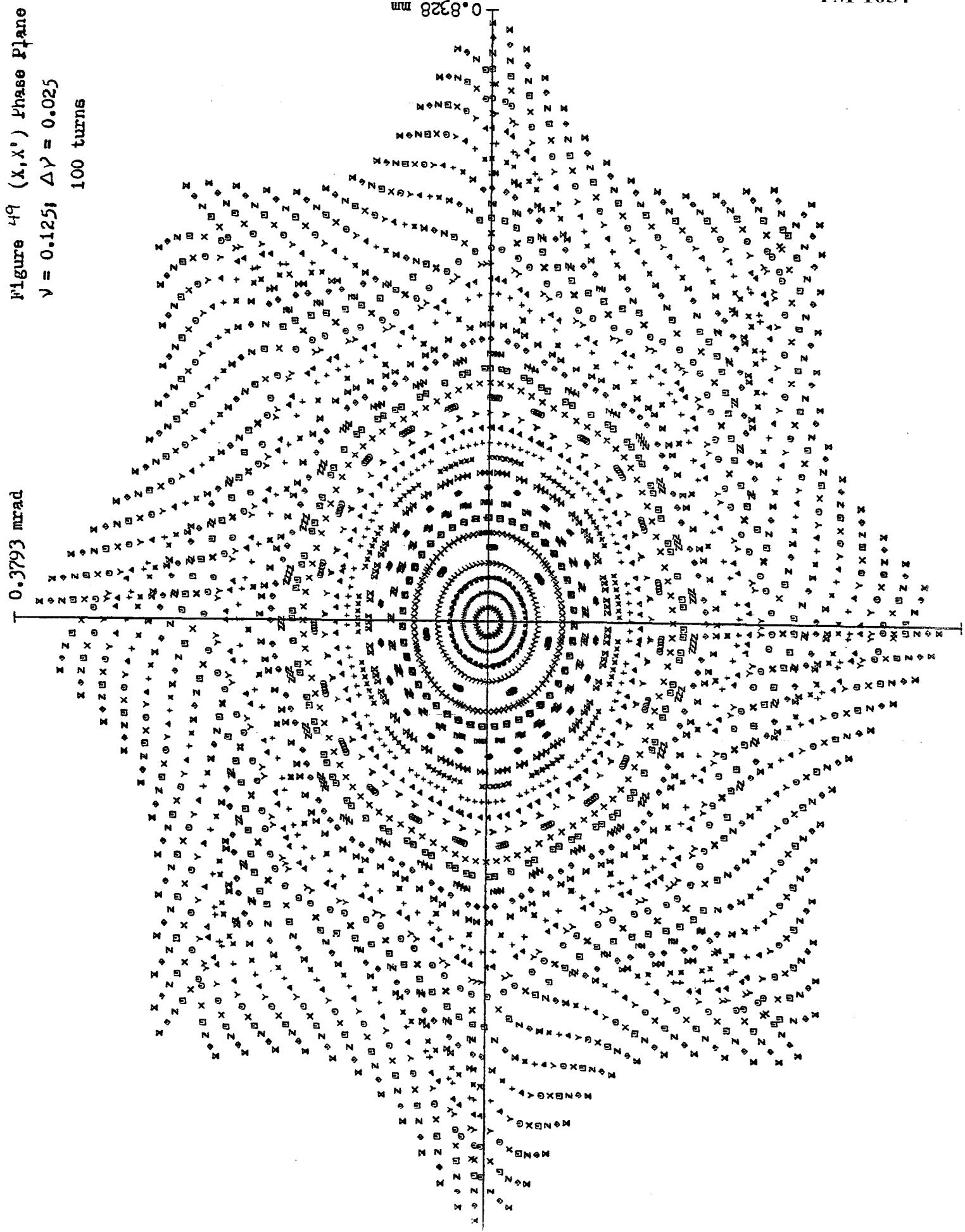


Figure 50 (X, X') Phase Plane

$\beta = 0.13; \Delta\gamma = 0.02$

100 turns

$T = 0.3879$ mrad

0.8328 mm

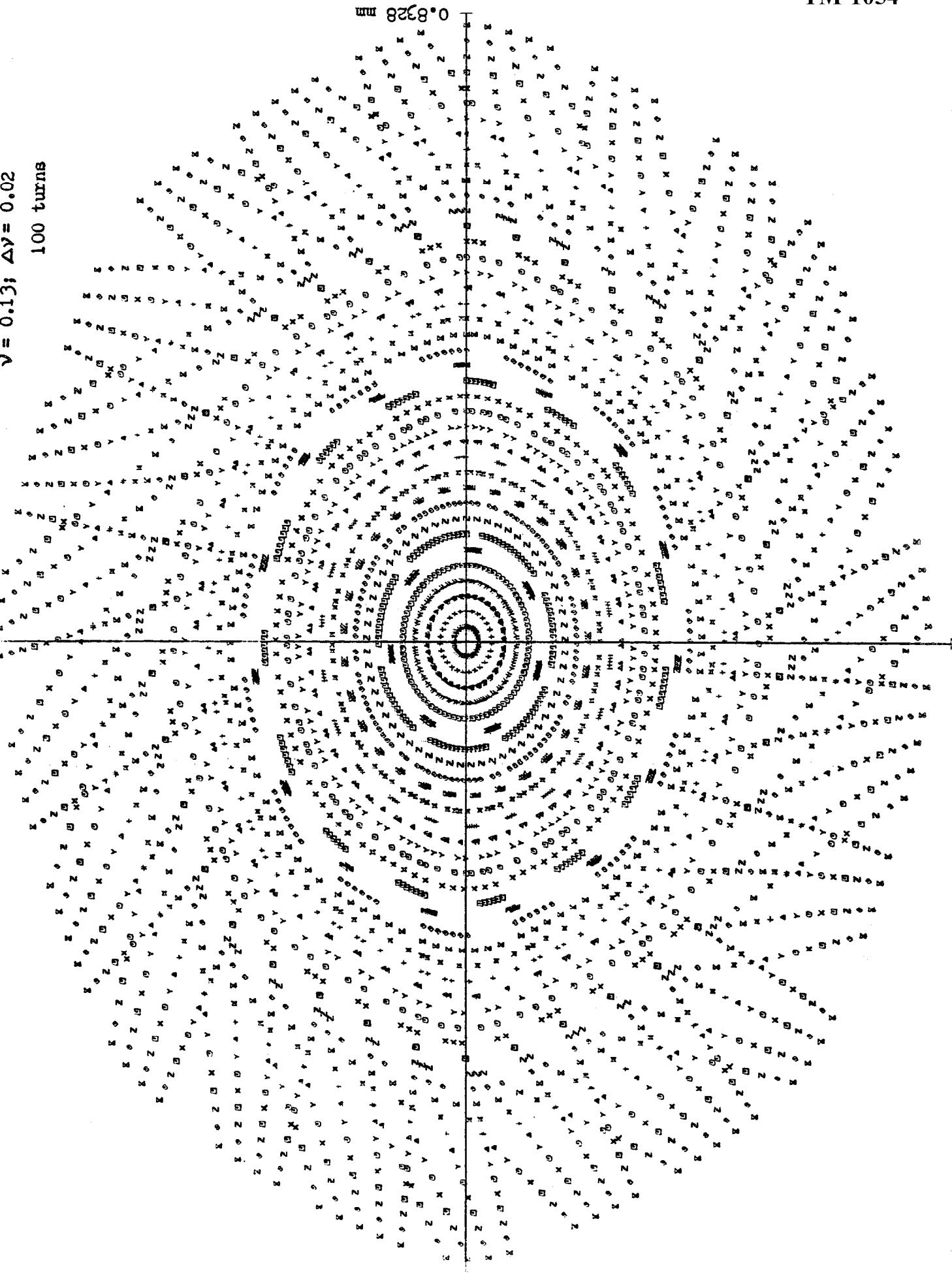


Figure 51
TM-1054

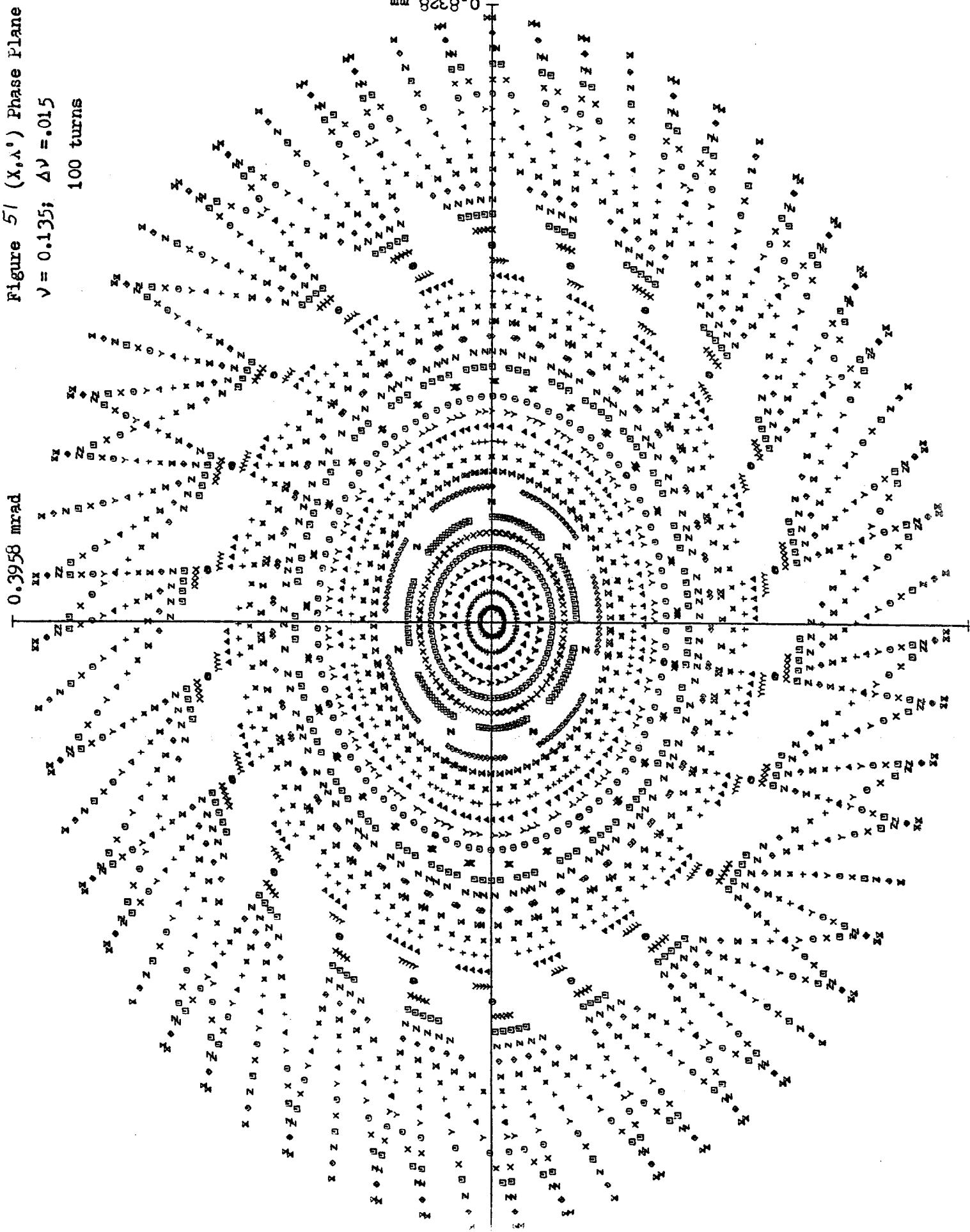


Figure 52
TM-1054

Figure 52 (x, x') Phase Plane

0.4054 mrad

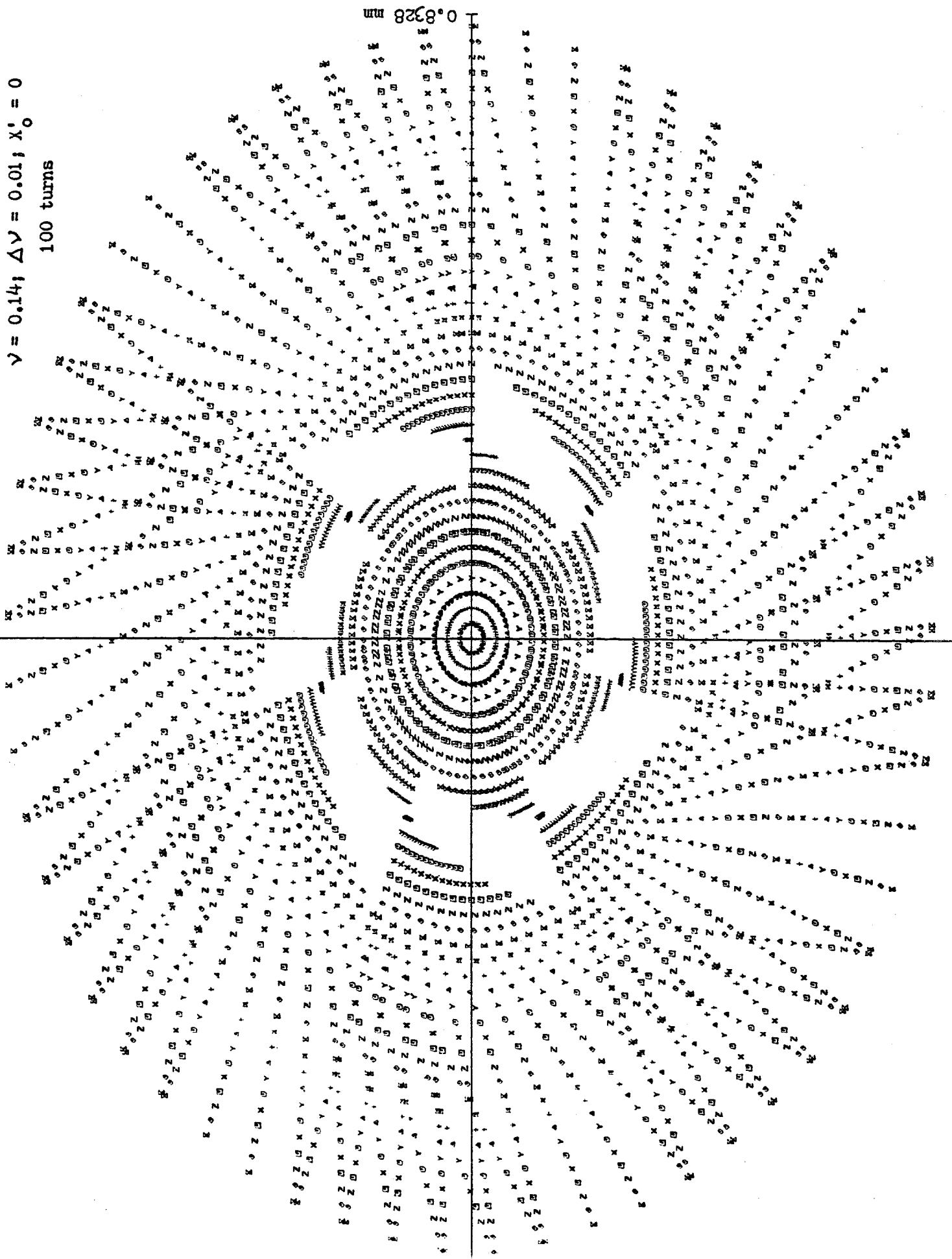


Figure 53

TM-1054

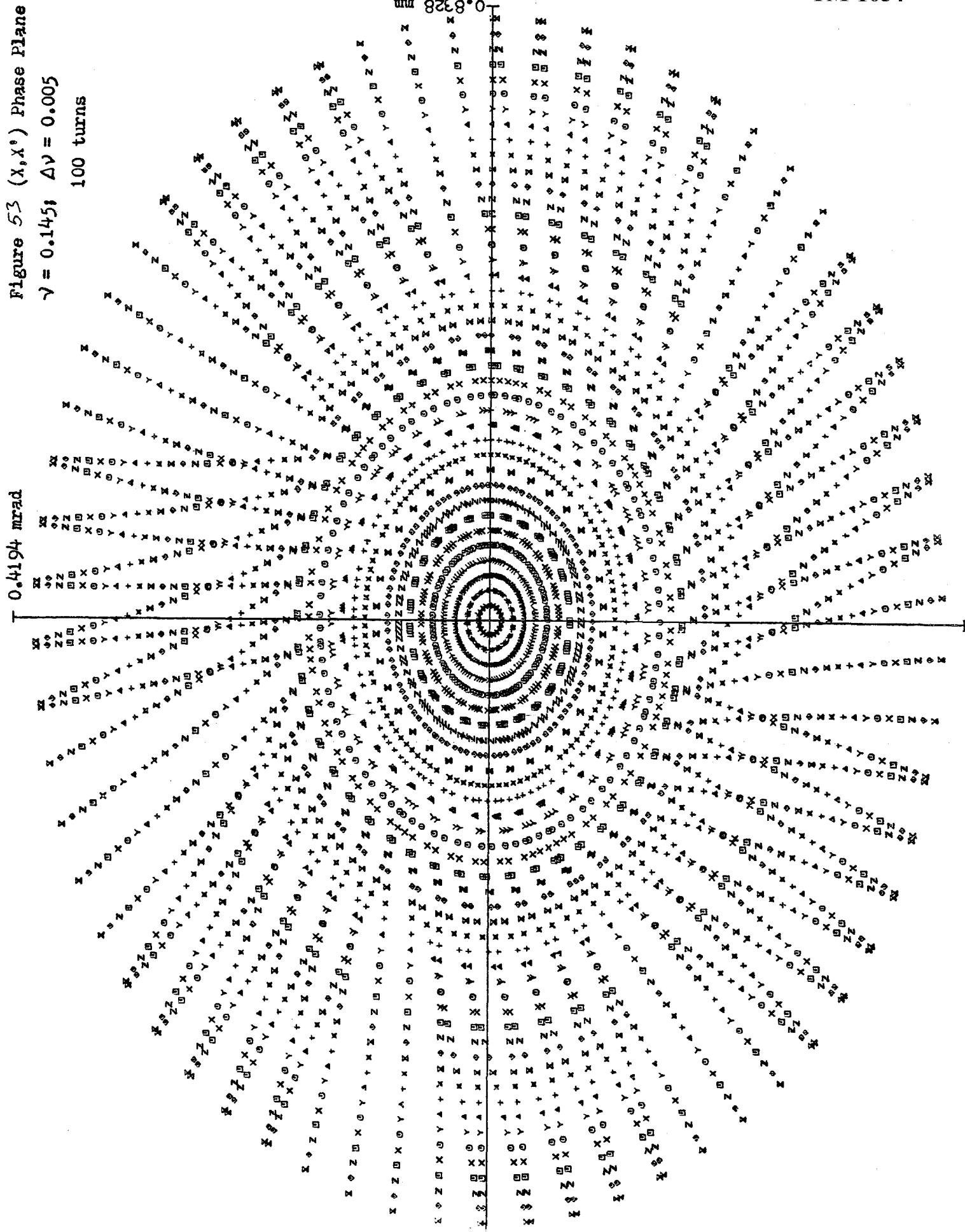
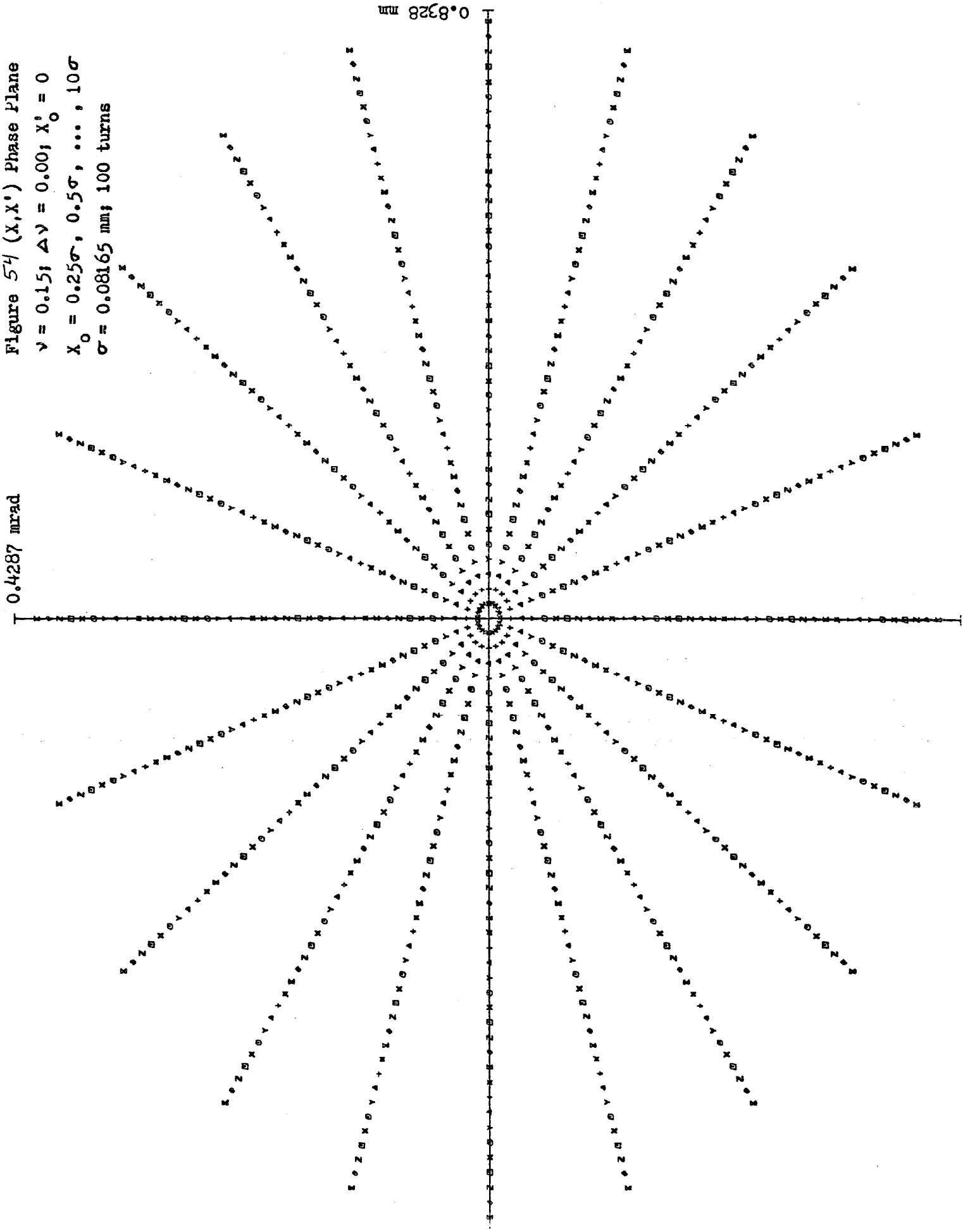


Figure 54
TM-1054

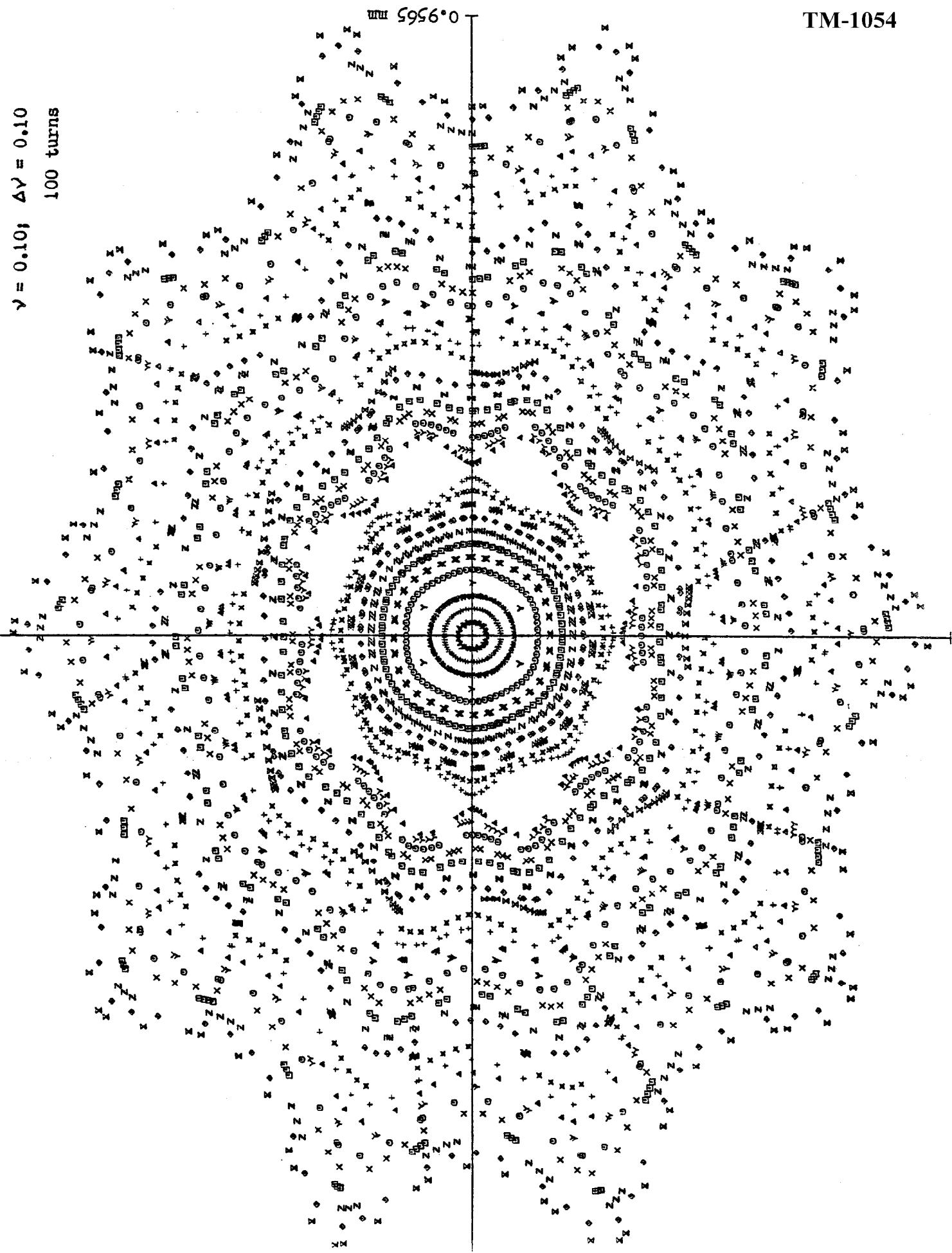
Figure 54 (X,X') Phase Plane
 $v = 0.15; \Delta v = 0.00; X_0' = 0$
 $X_0 = 0.25\sigma, 0.5\sigma, \dots, 10\sigma$
 $\sigma = 0.08165 \text{ mm}; 100 \text{ turns}$



TM-1054

Figure 55 (X, X') Phase Plane $\gamma = 0.10; \Delta\gamma = 0.10$

100 turns

 $T = 0.3440 \text{ mrad}$ 

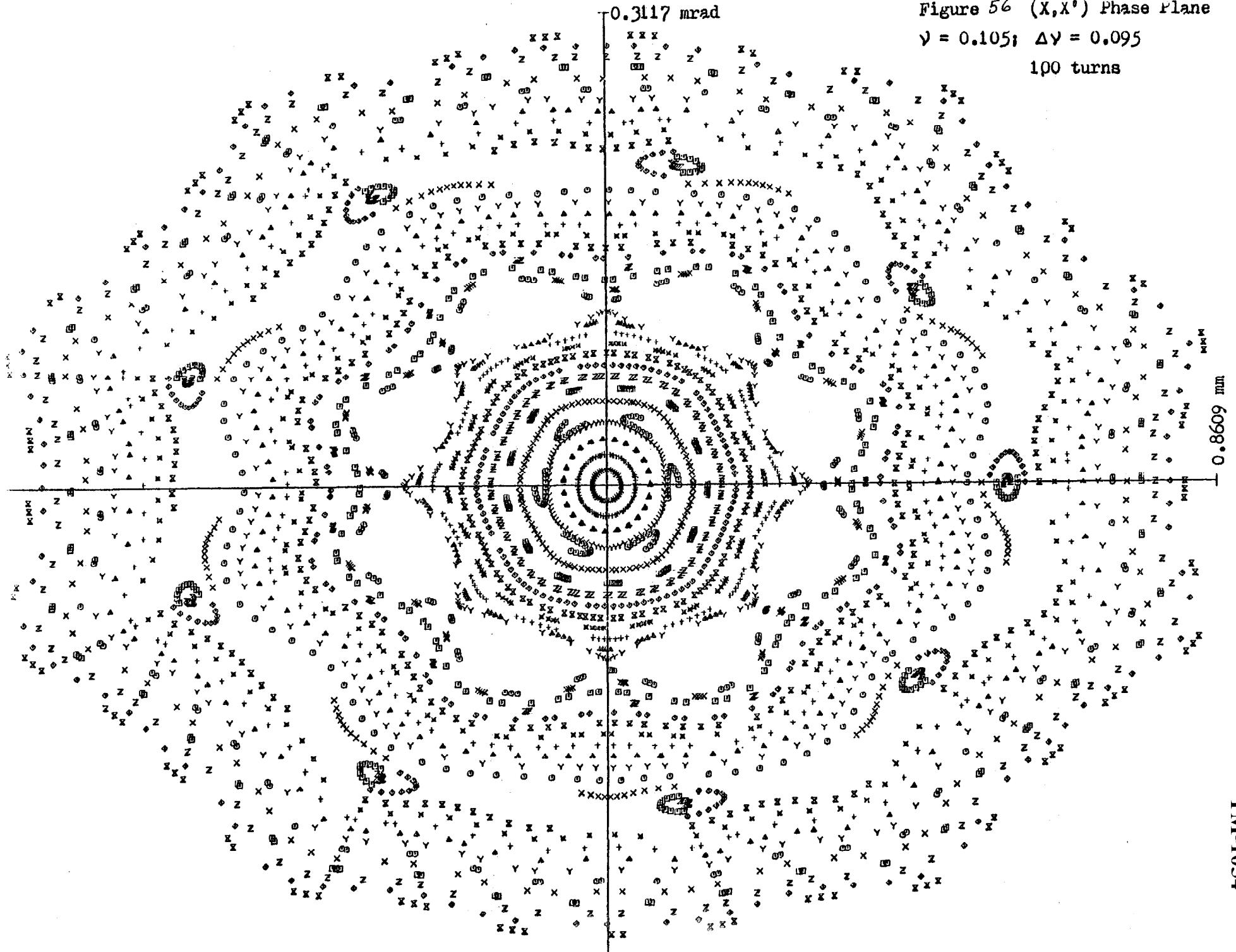
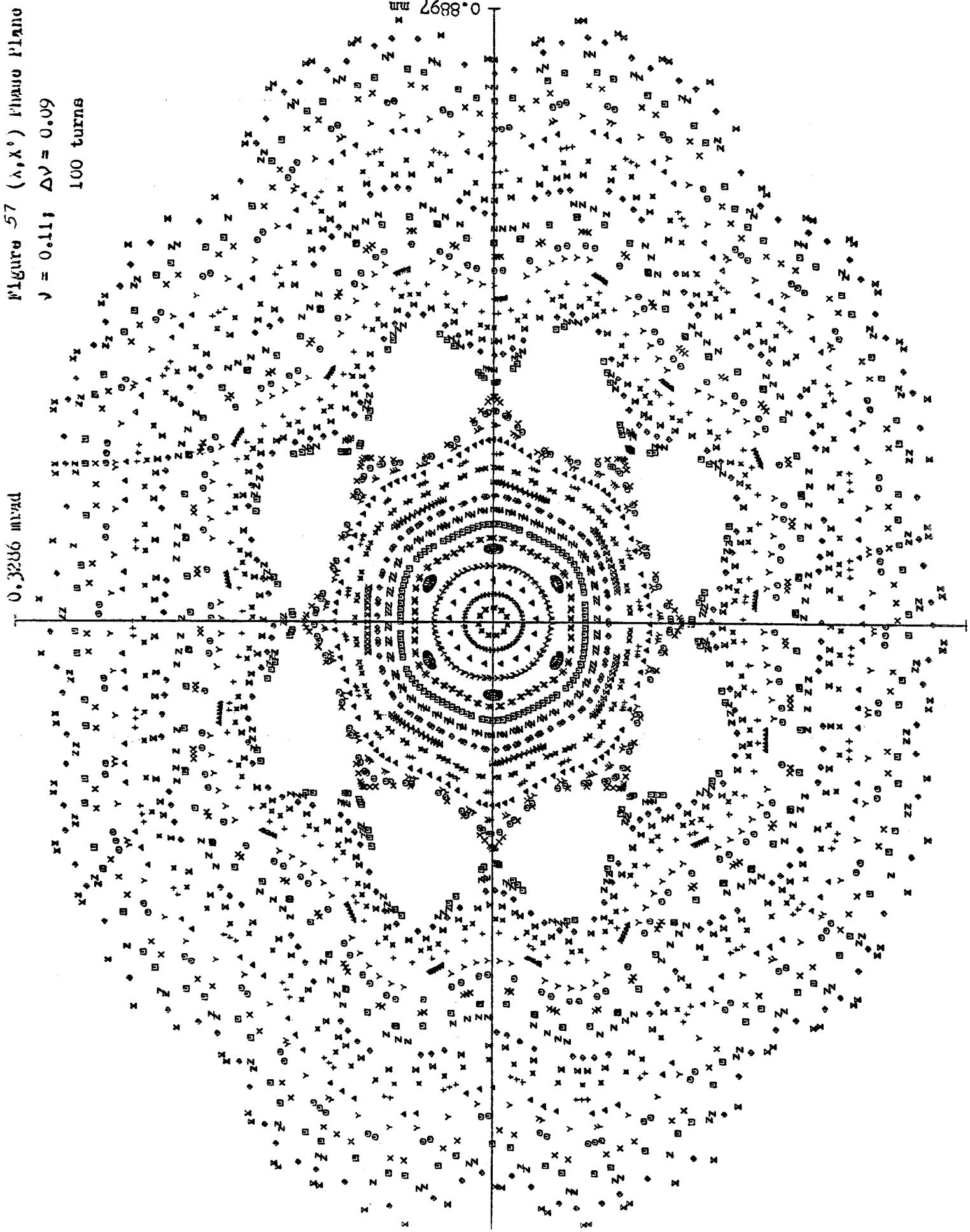


Figure 56
TM-1054

Figure 57
TM-1054



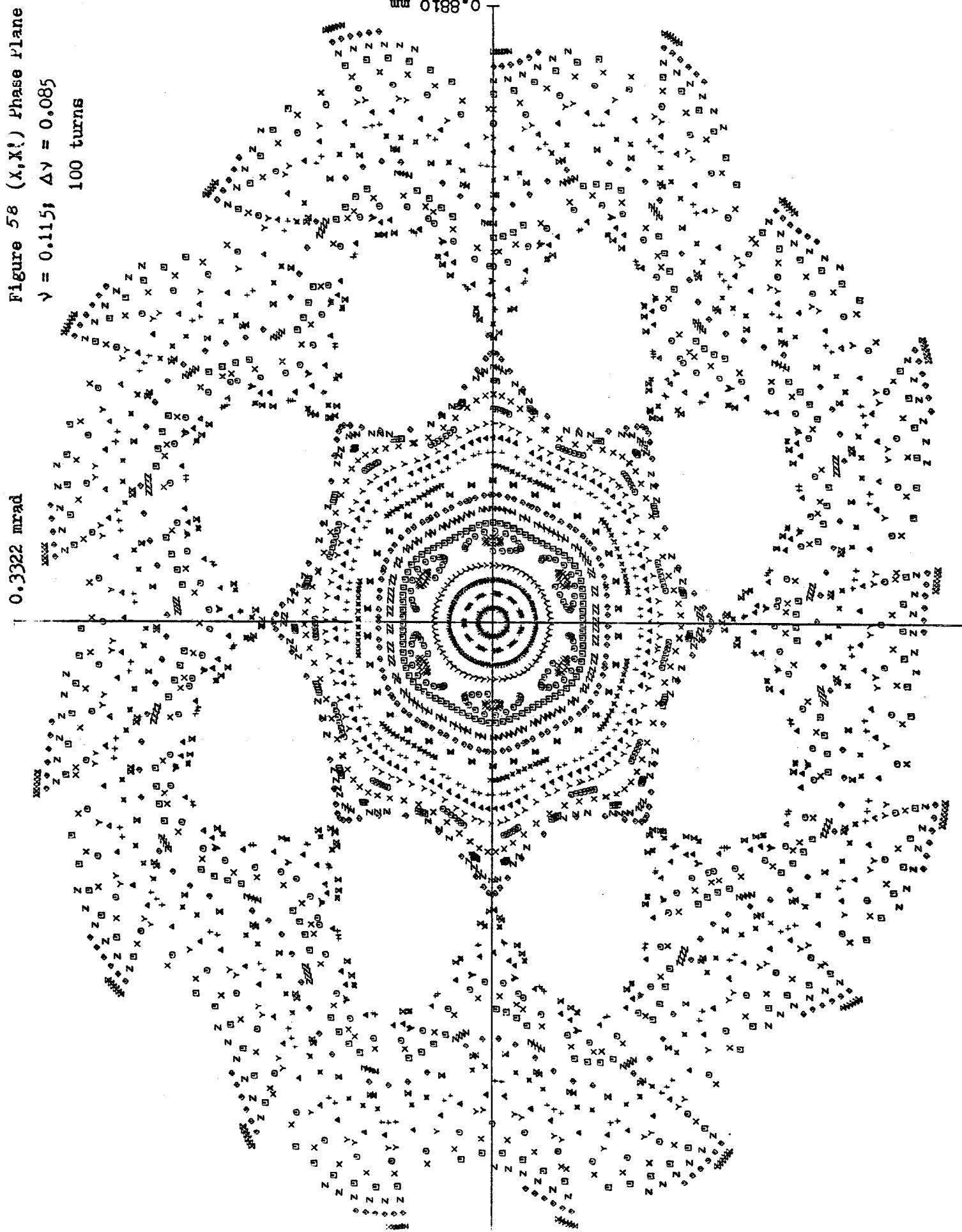


Figure 59
TM-1054

Figure 59 (χ, χ') Phase Plane

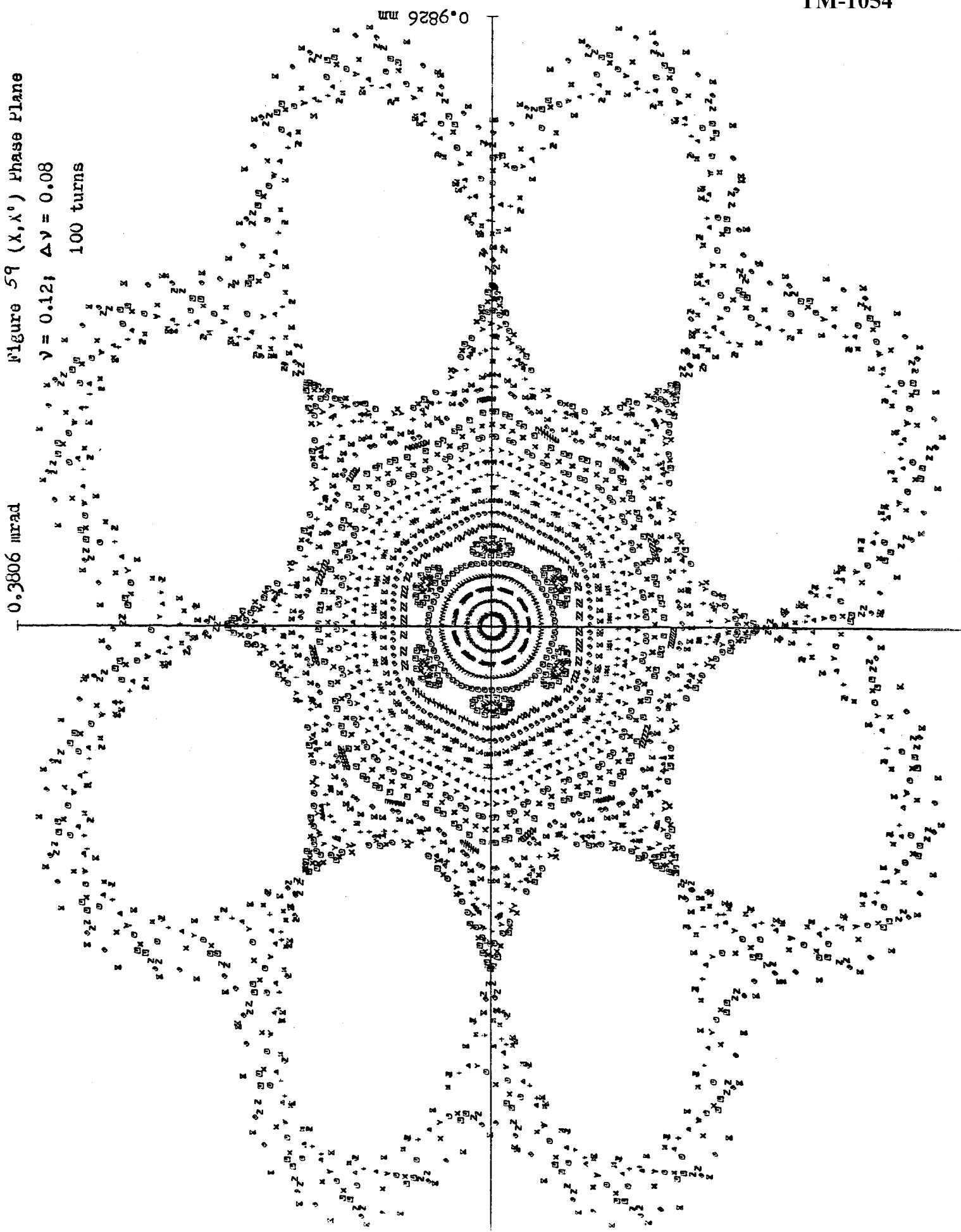


Figure 60
TM-1054

Figure 60 (X, X') Phase Plane

$$\gamma = 0.1251 \quad \Delta\gamma = 0.075$$

100 turns

T 0.3307 mrad

0.8328 mm

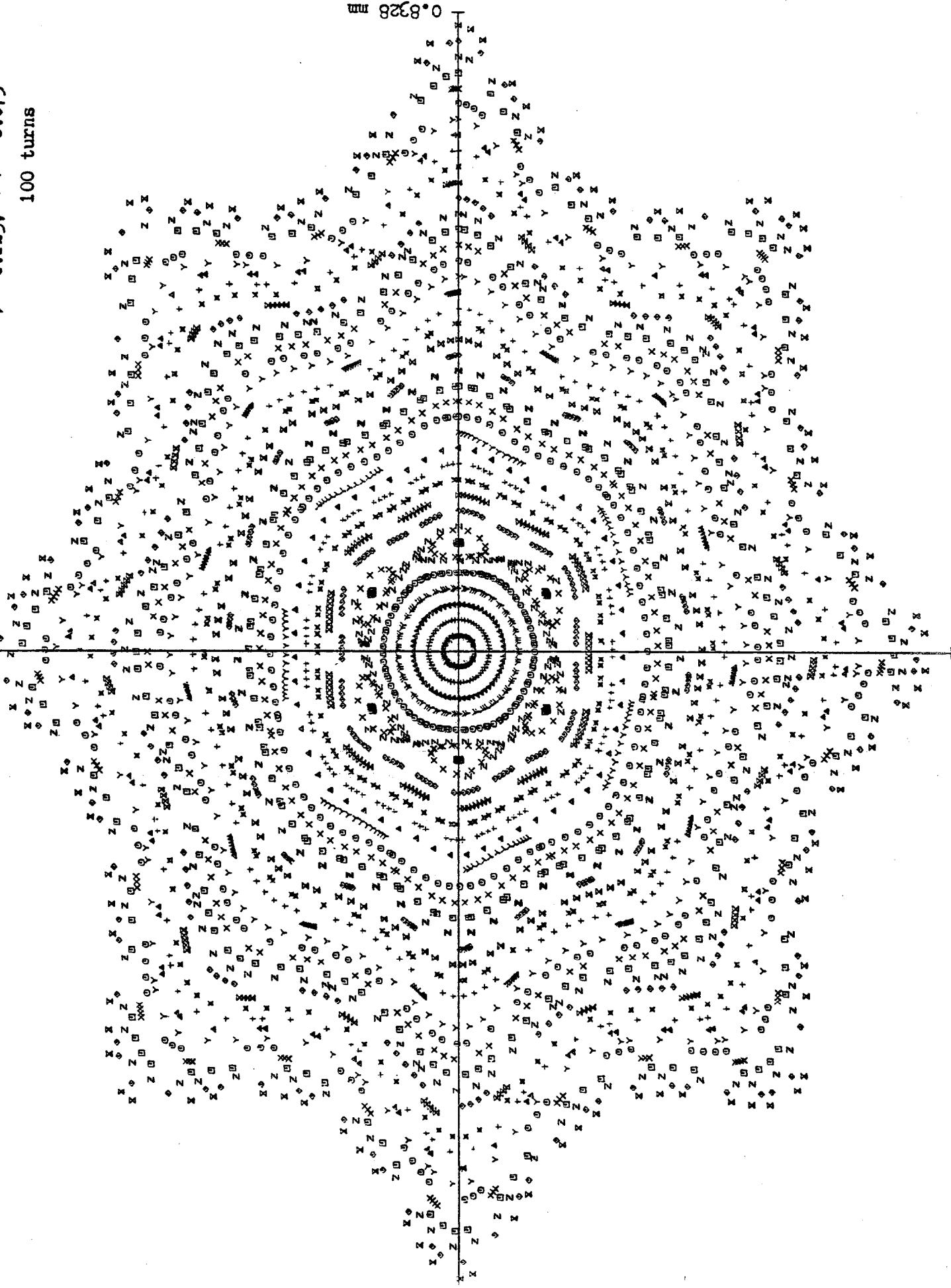


Figure 61
TM-1054

Figure 61 (X,X') Phase Plane

0.3333 mrad

$\gamma = 0.13; \Delta\gamma = 0.07$

100 turns

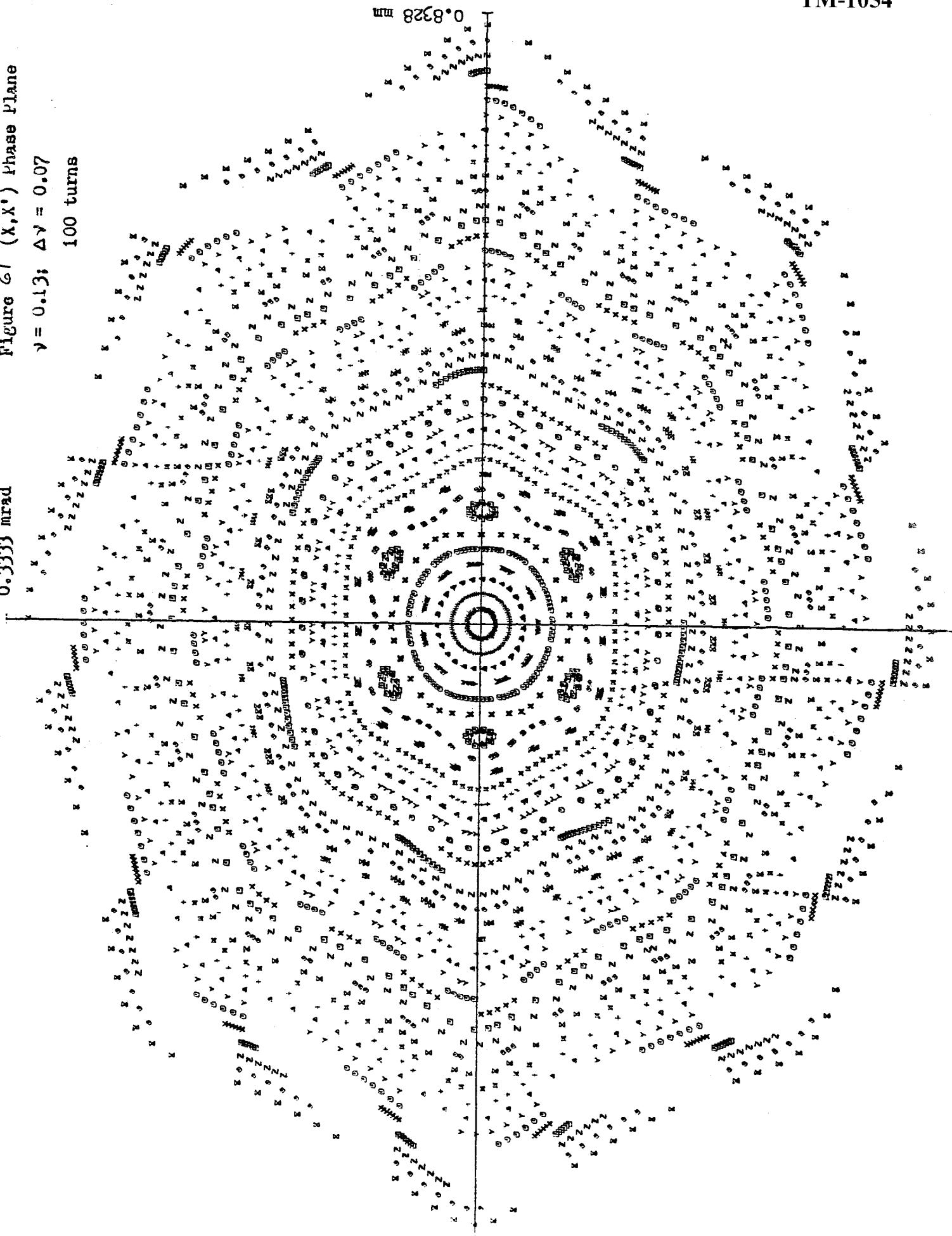


Figure 62
TM-1054

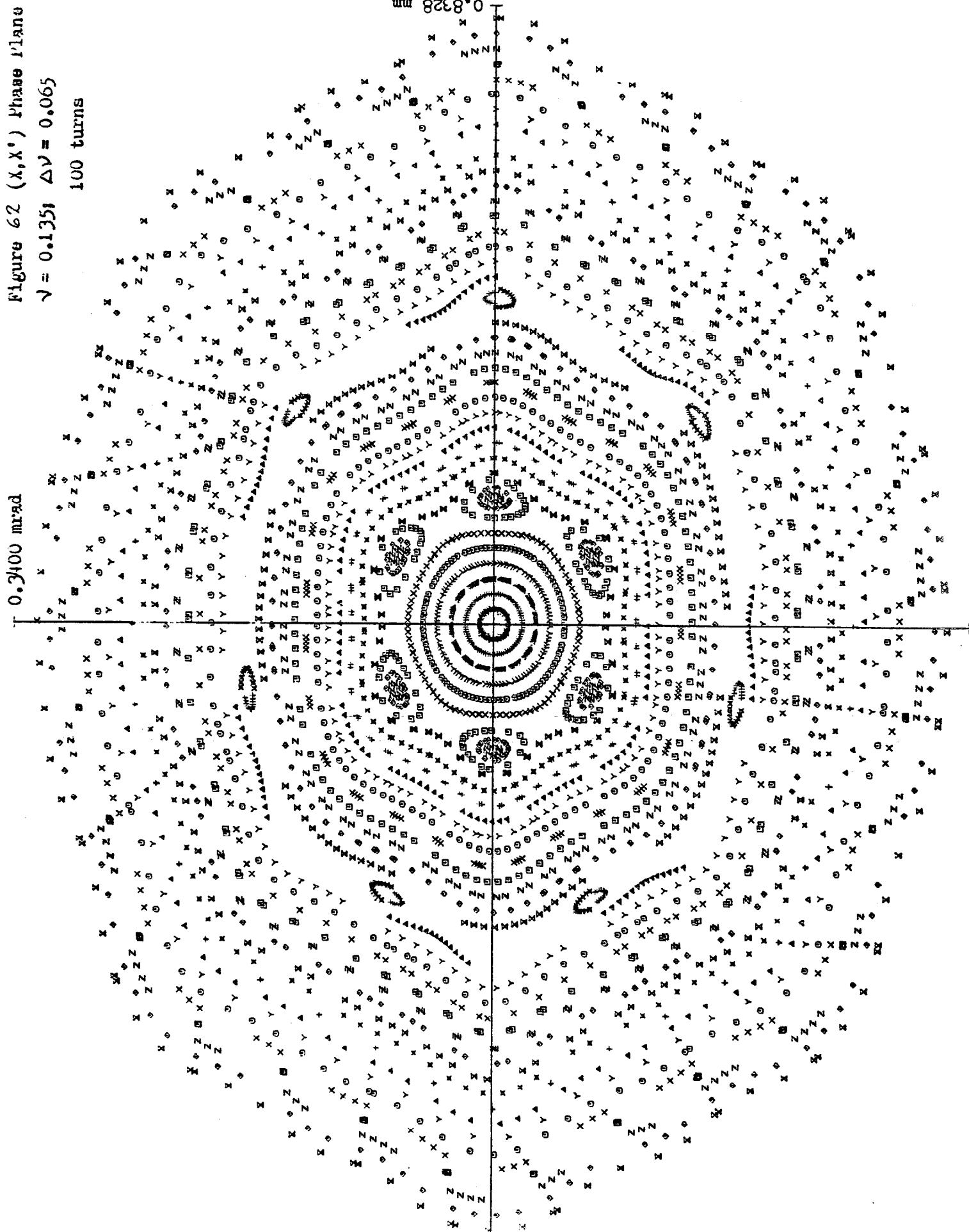


Figure 63
TM-1054

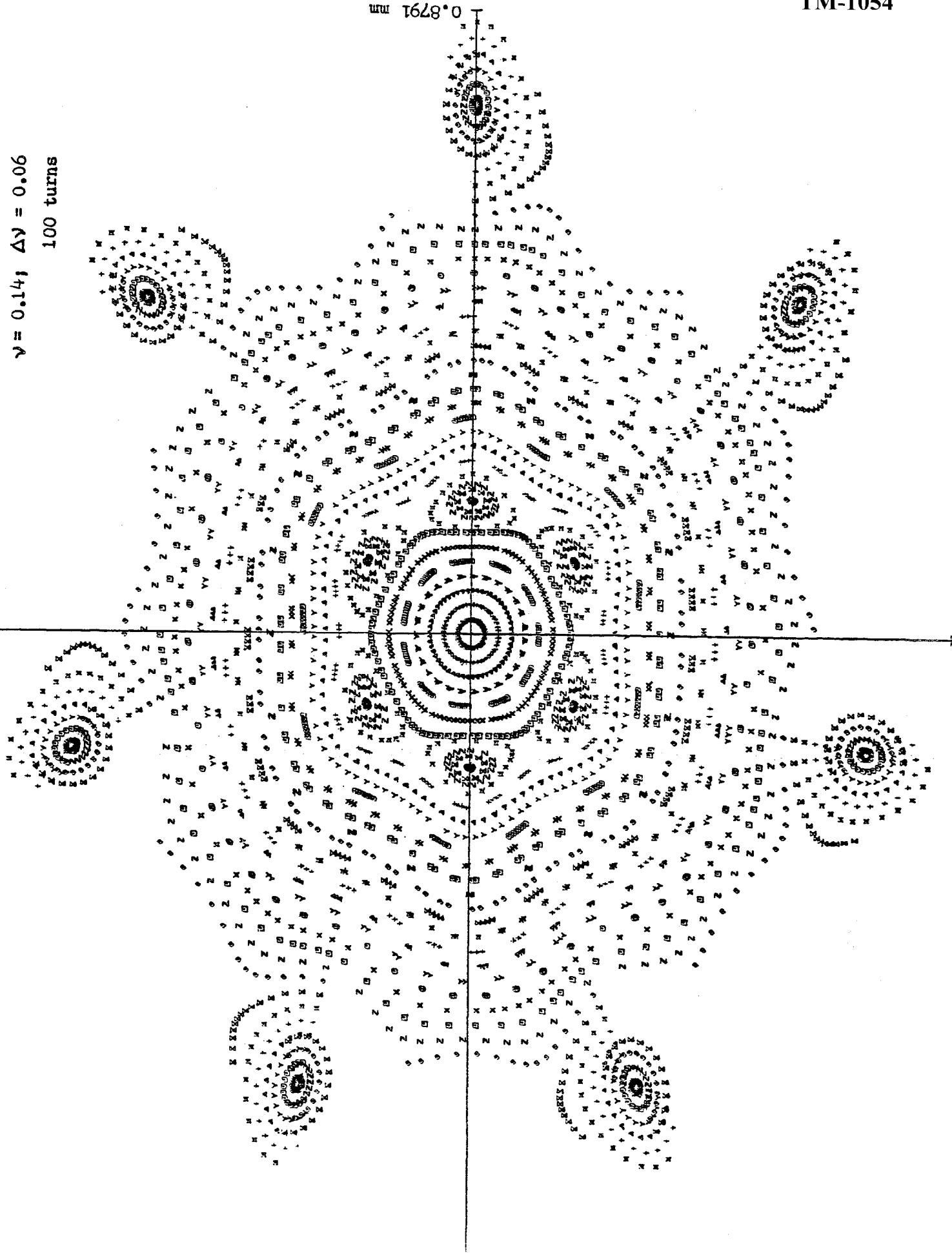
Figure 63 (X, X') Phase Plane

$\gamma = 0.14$; $\Delta\gamma = 0.06$

100 turns

0.3588 mrad

0.8791 mm



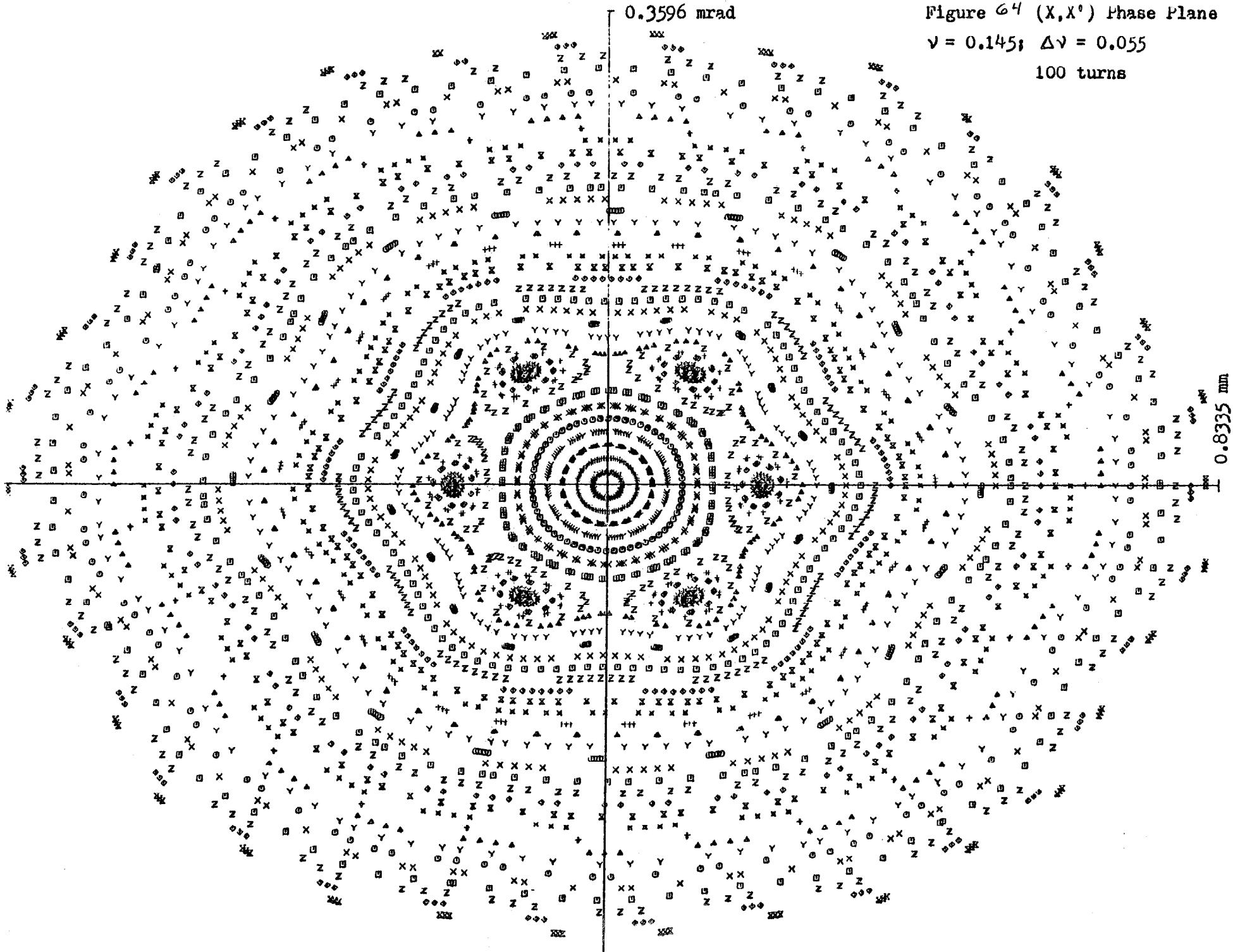
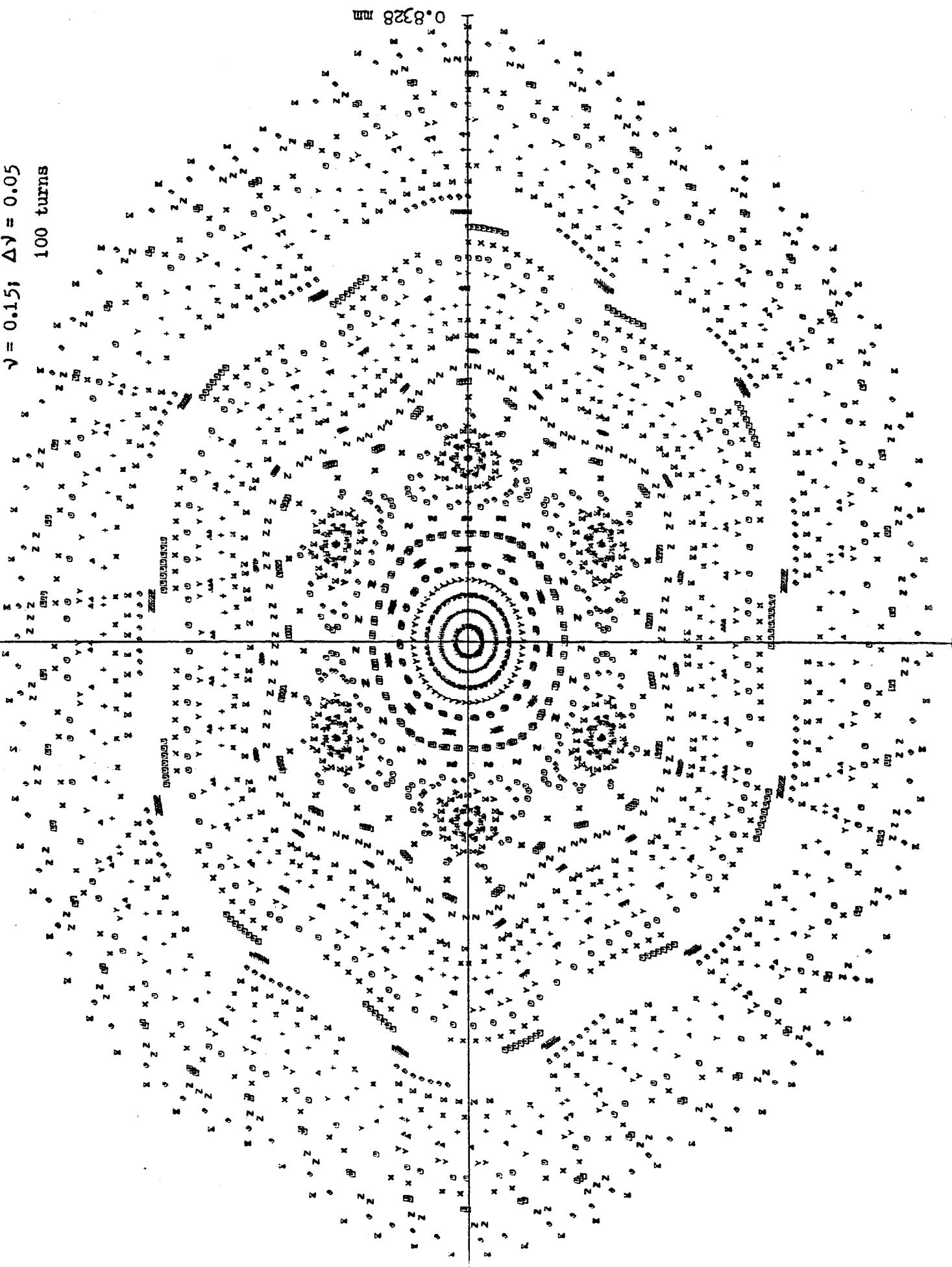


Figure 64
TM-1054

Figure 65
TM-1054

Figure 65 (x, x') Phase Plane

± 0.3582 mrad



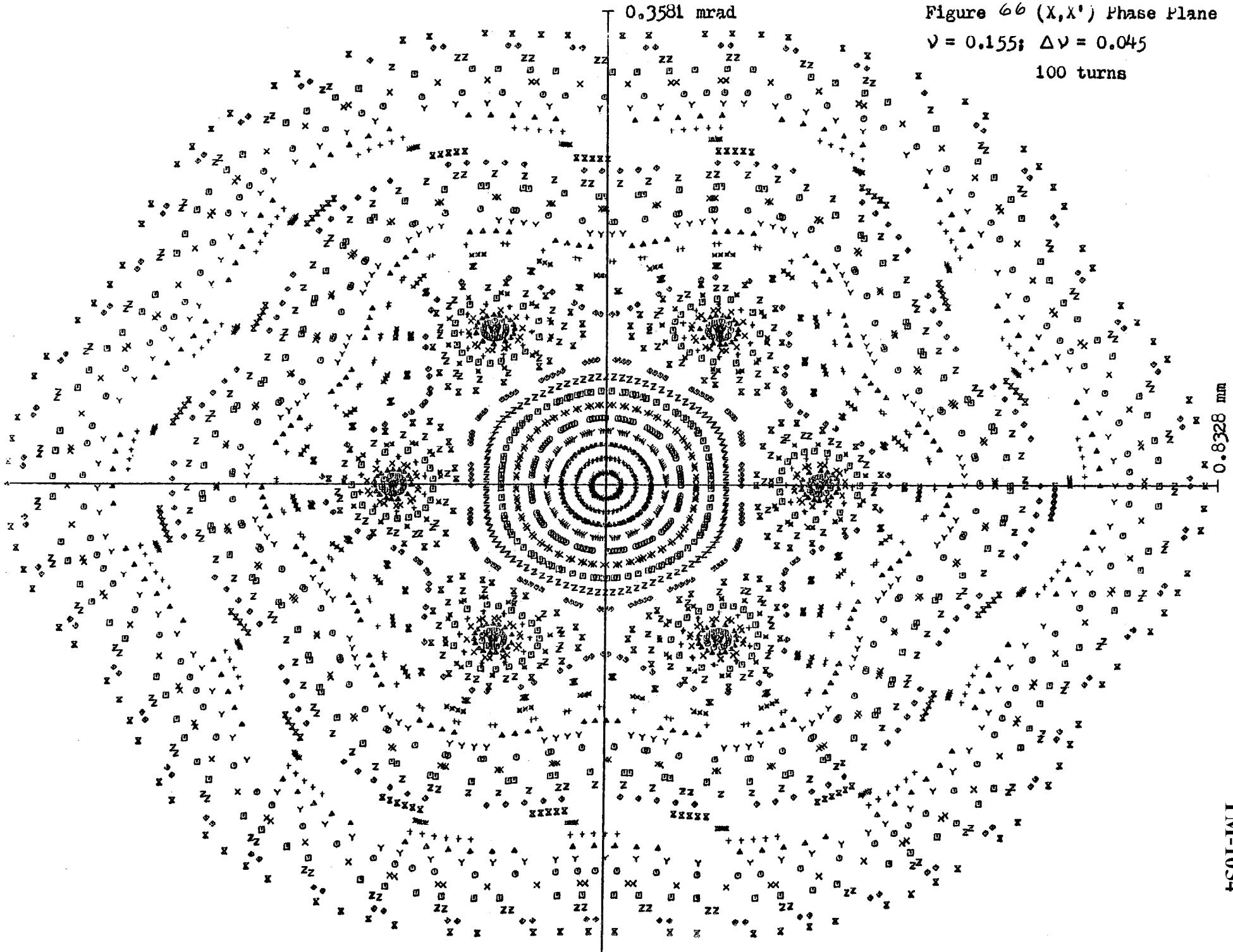


Figure 67
TM-1054

Figure 67 (X, X') Phase Plane

0.03587 mrad

$\beta = 0.16$; $\Delta v = 0.04$

100 turns

0.8328 mm

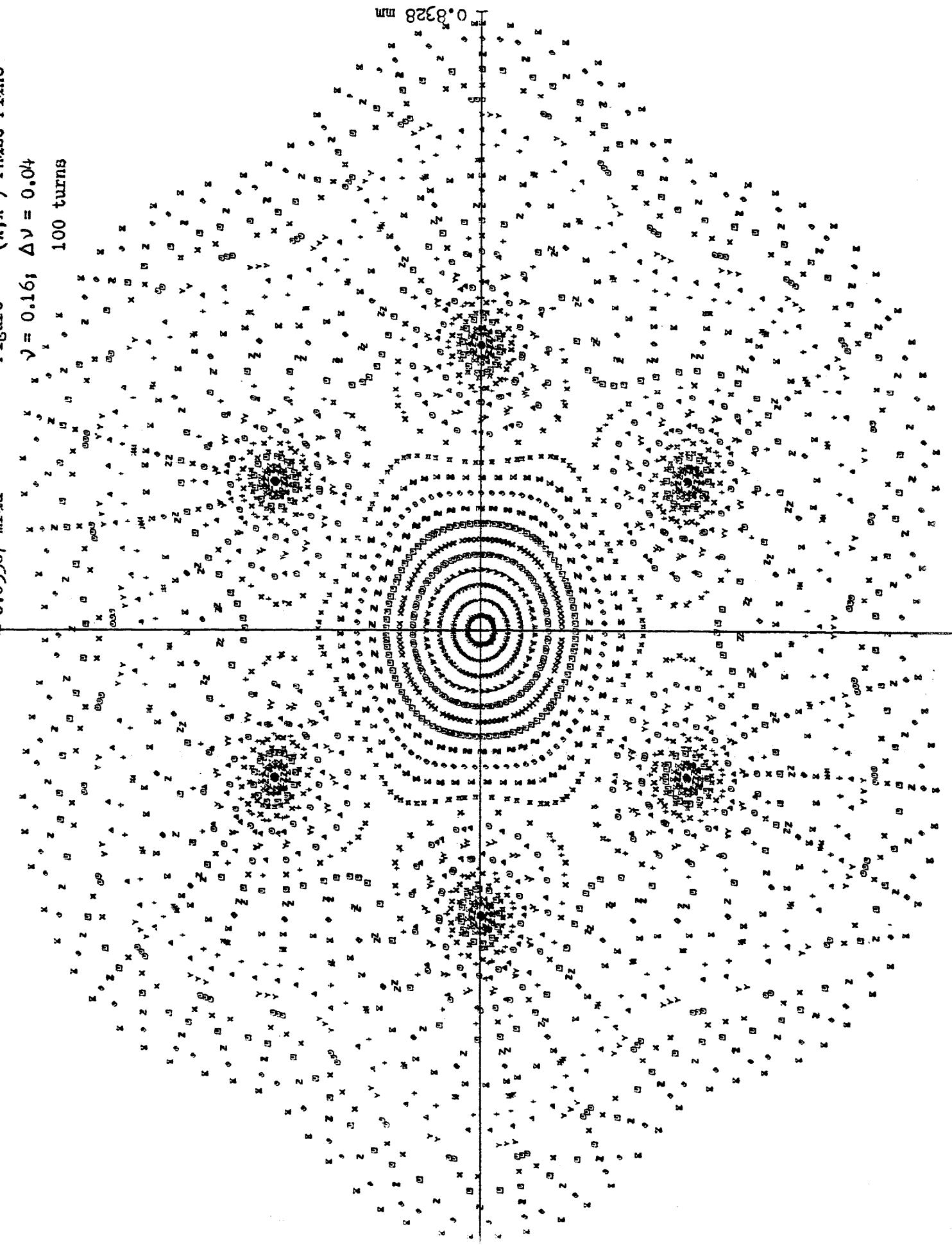


Figure 68
TM-1054

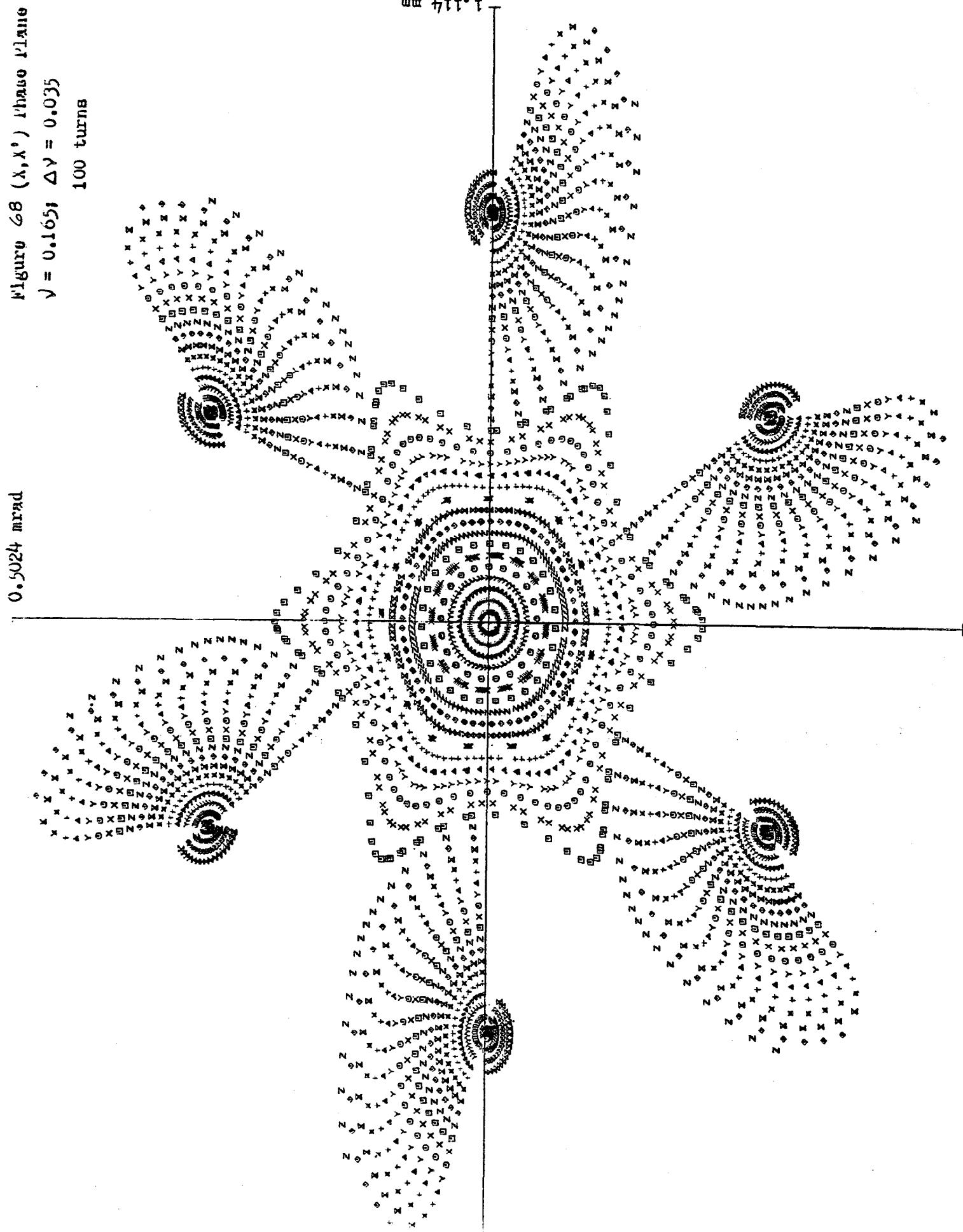


Figure 69
TM-1054

Figure 69 (λ, λ') Phase Plane

$\gamma = 0.17; \Delta\gamma = 0.03$

100 turns

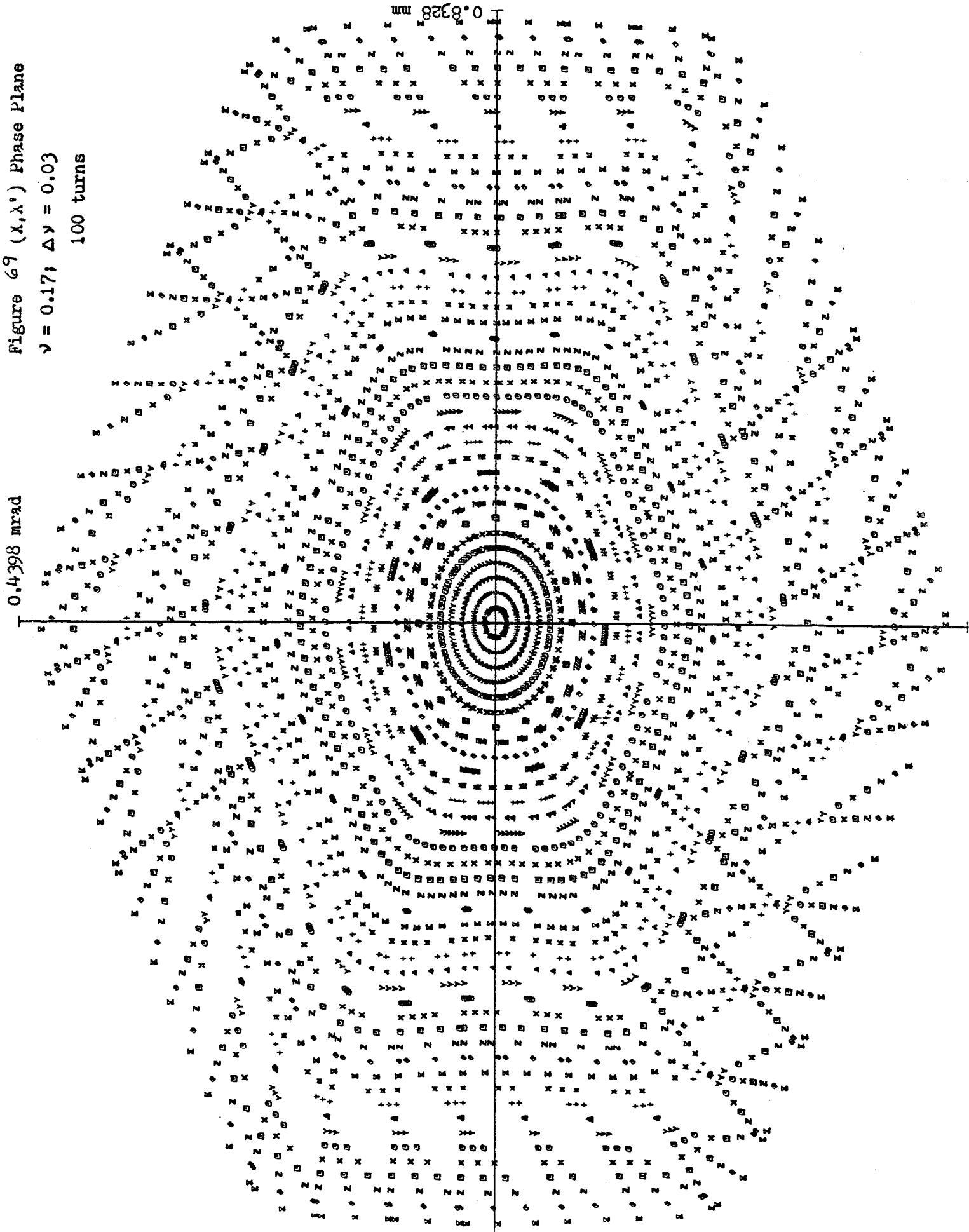


Figure 70
TM-1054

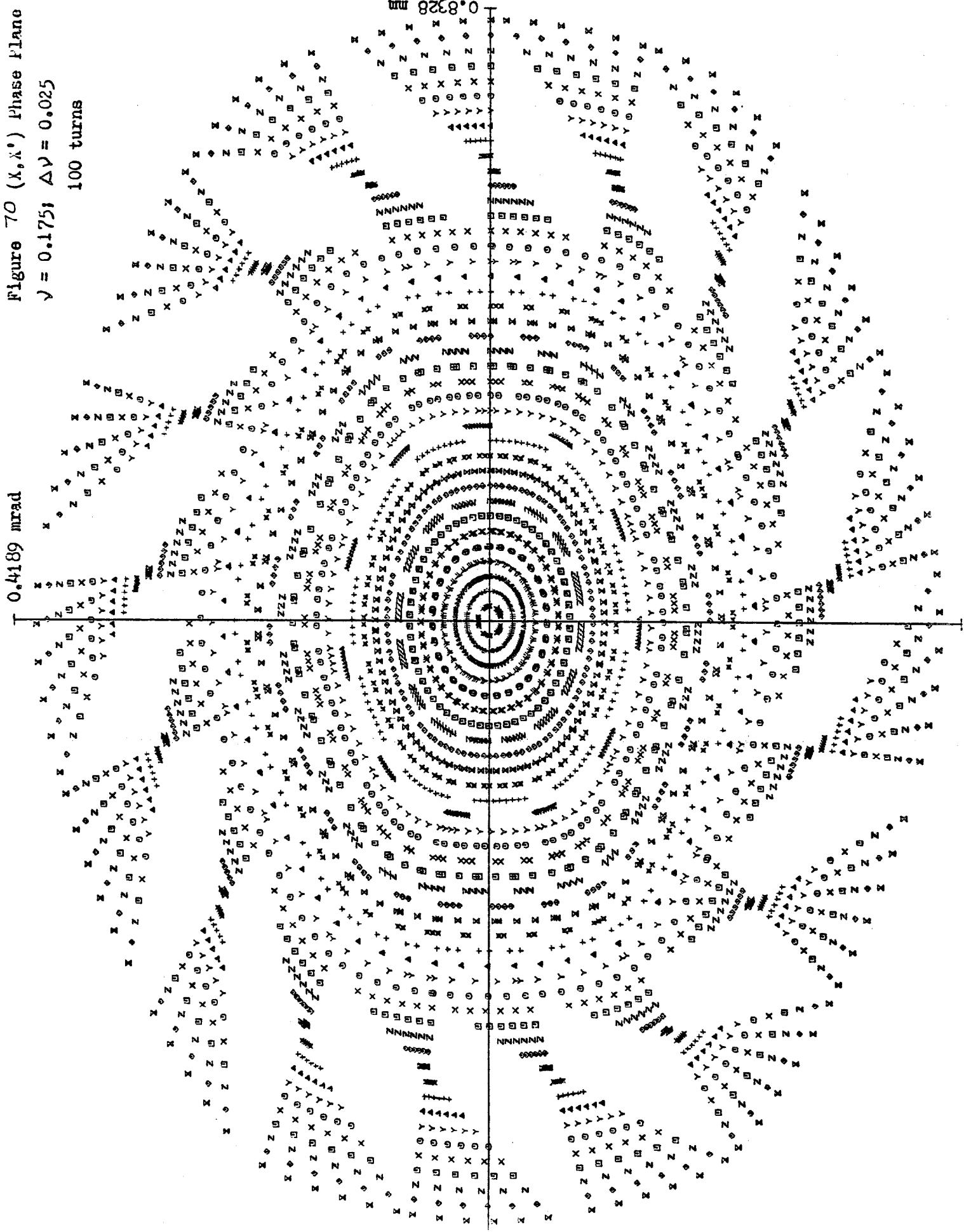


Figure 71
TM-1054

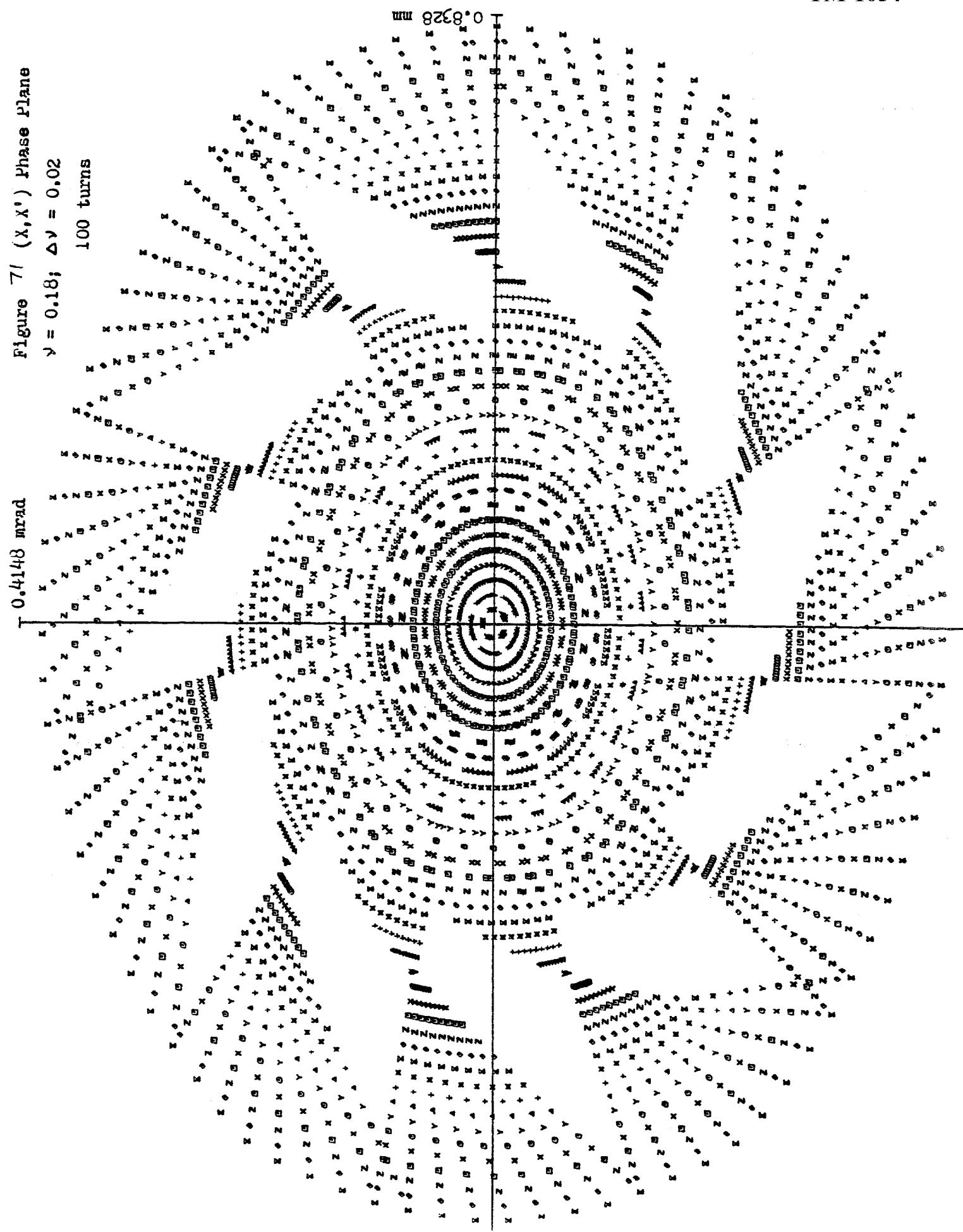


Figure 72
TM-1054

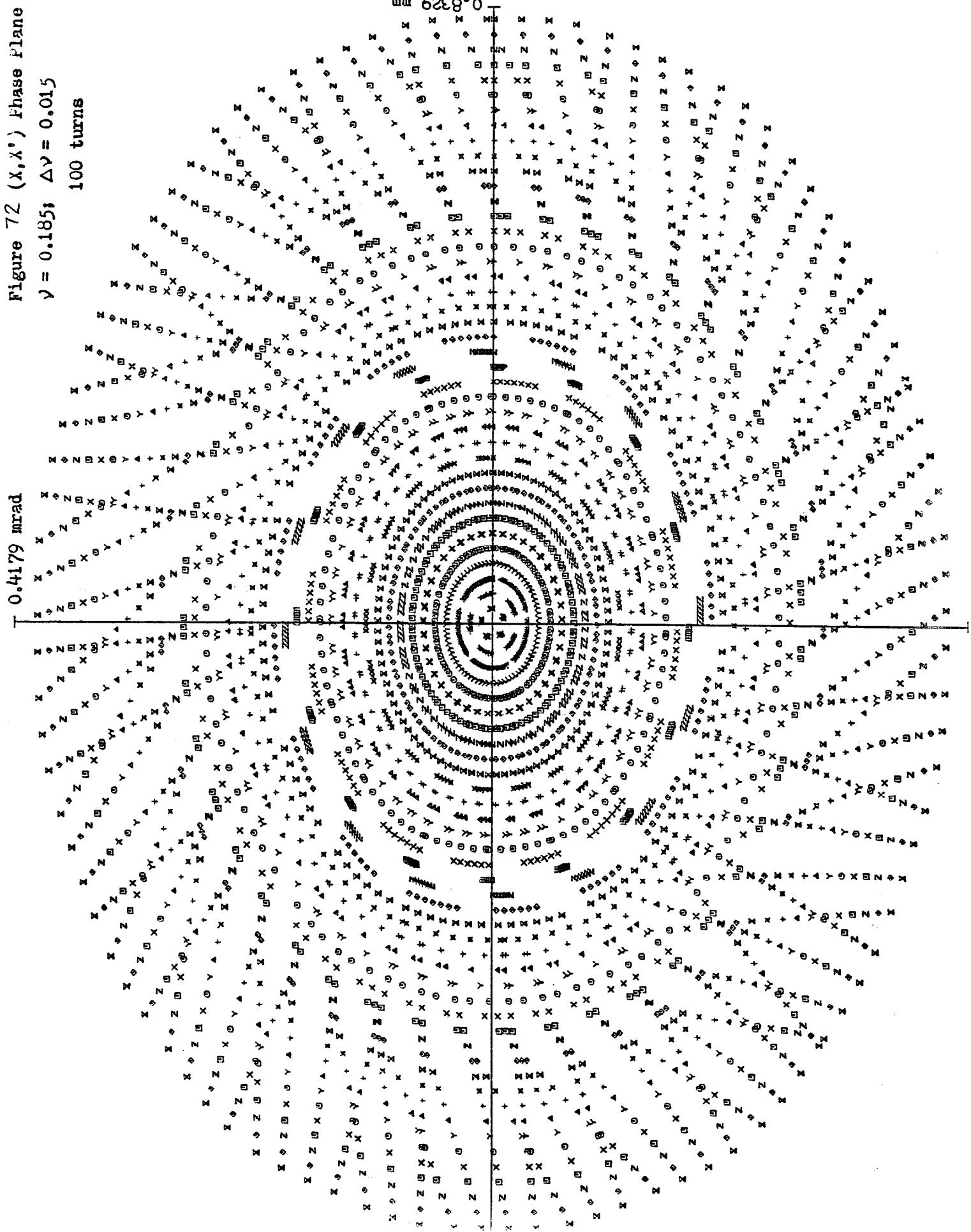
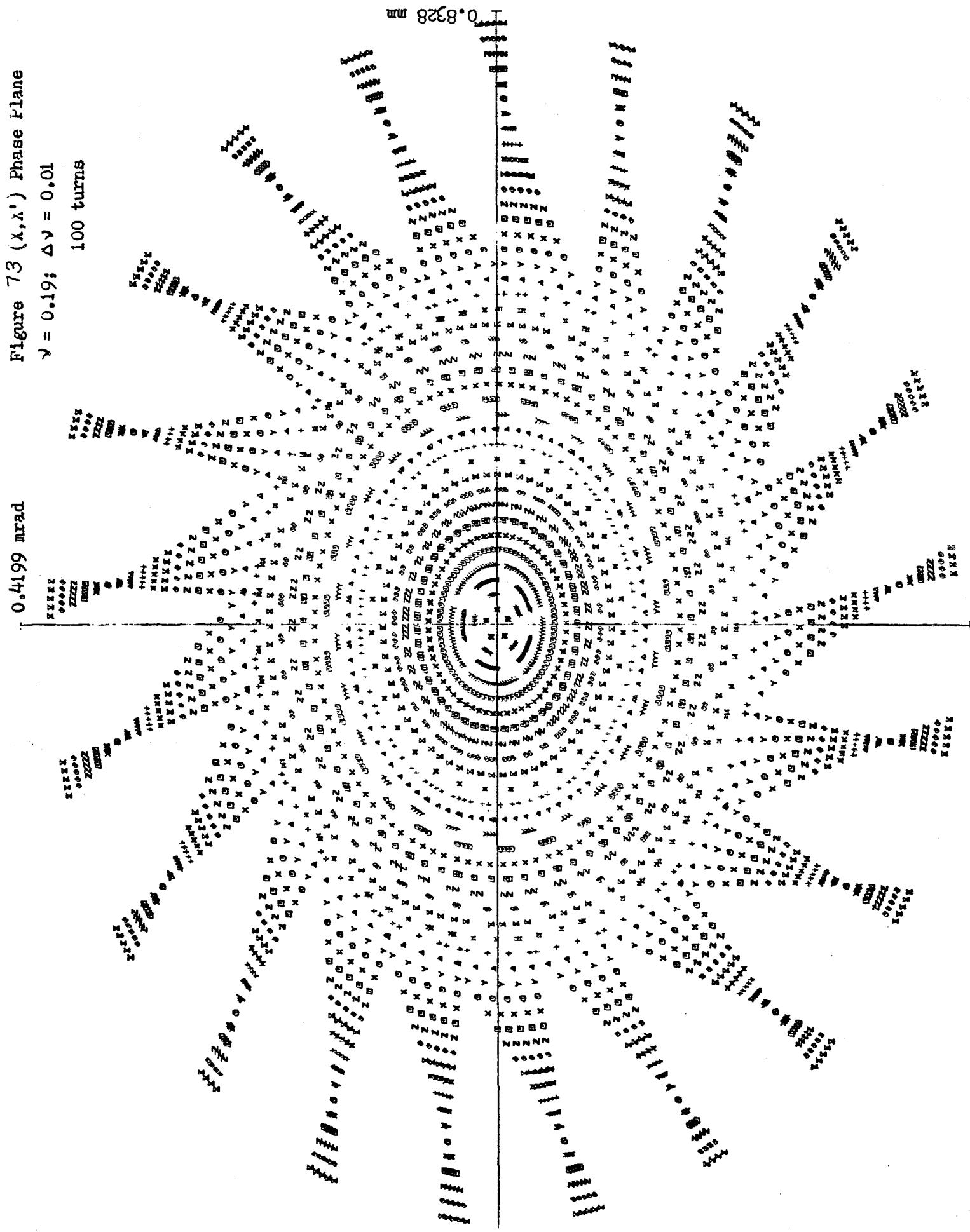


Figure 73
TM-1054

Figure 73 (x, x') Phase Plane

$\gamma = 0.19$; $\Delta \gamma = 0.01$
100 turns

0.4199 mrad



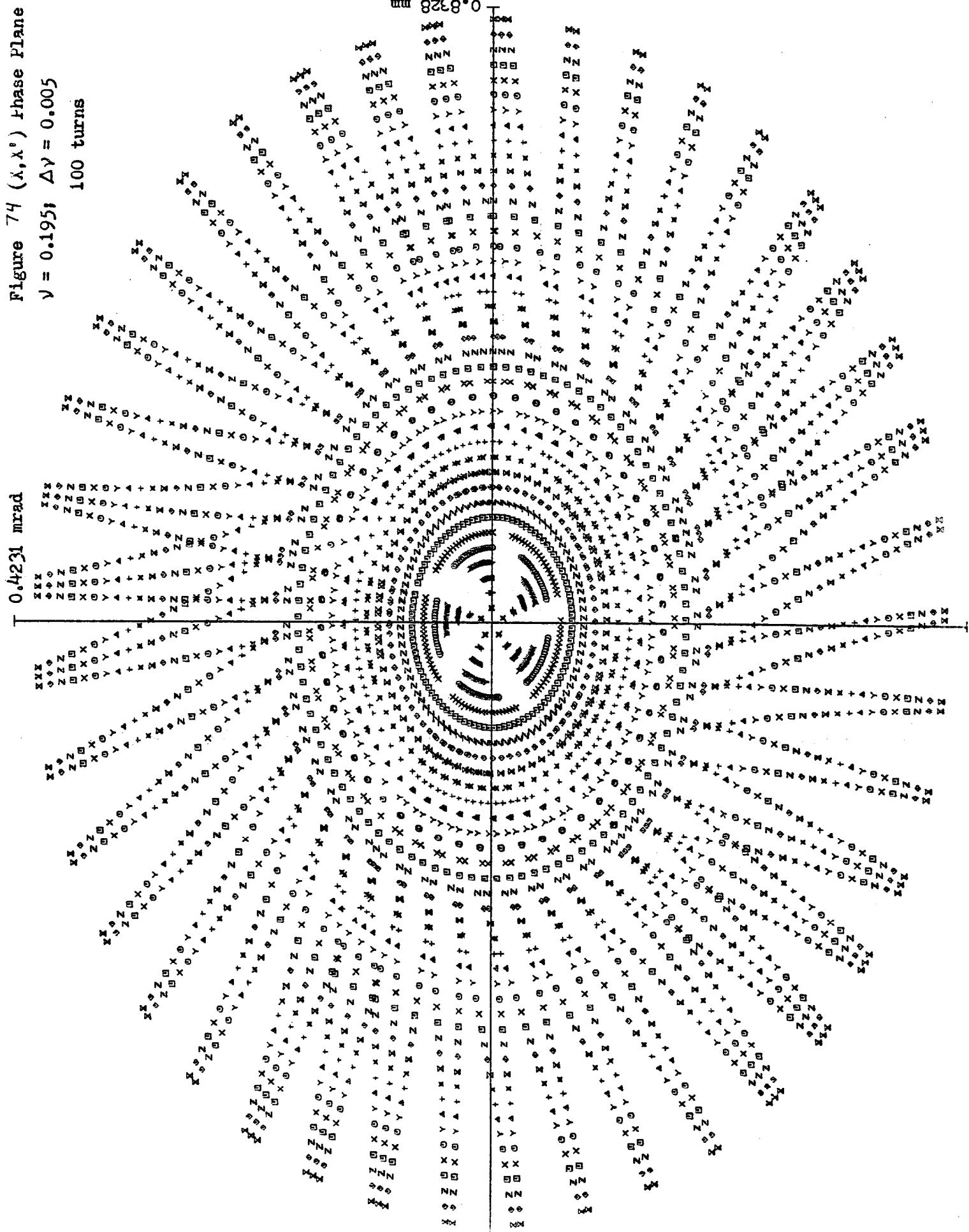


Figure 75 (X,X') Phase Plane
 $y = 0.20$; $\Delta \psi = 0.00$; $X'_0 = 0$
 $X_0 = 0.25\sigma, 0.5\sigma, \dots, 10\sigma$
 $\sigma = 0.08165 \text{ mm}; 100 \text{ turns}$

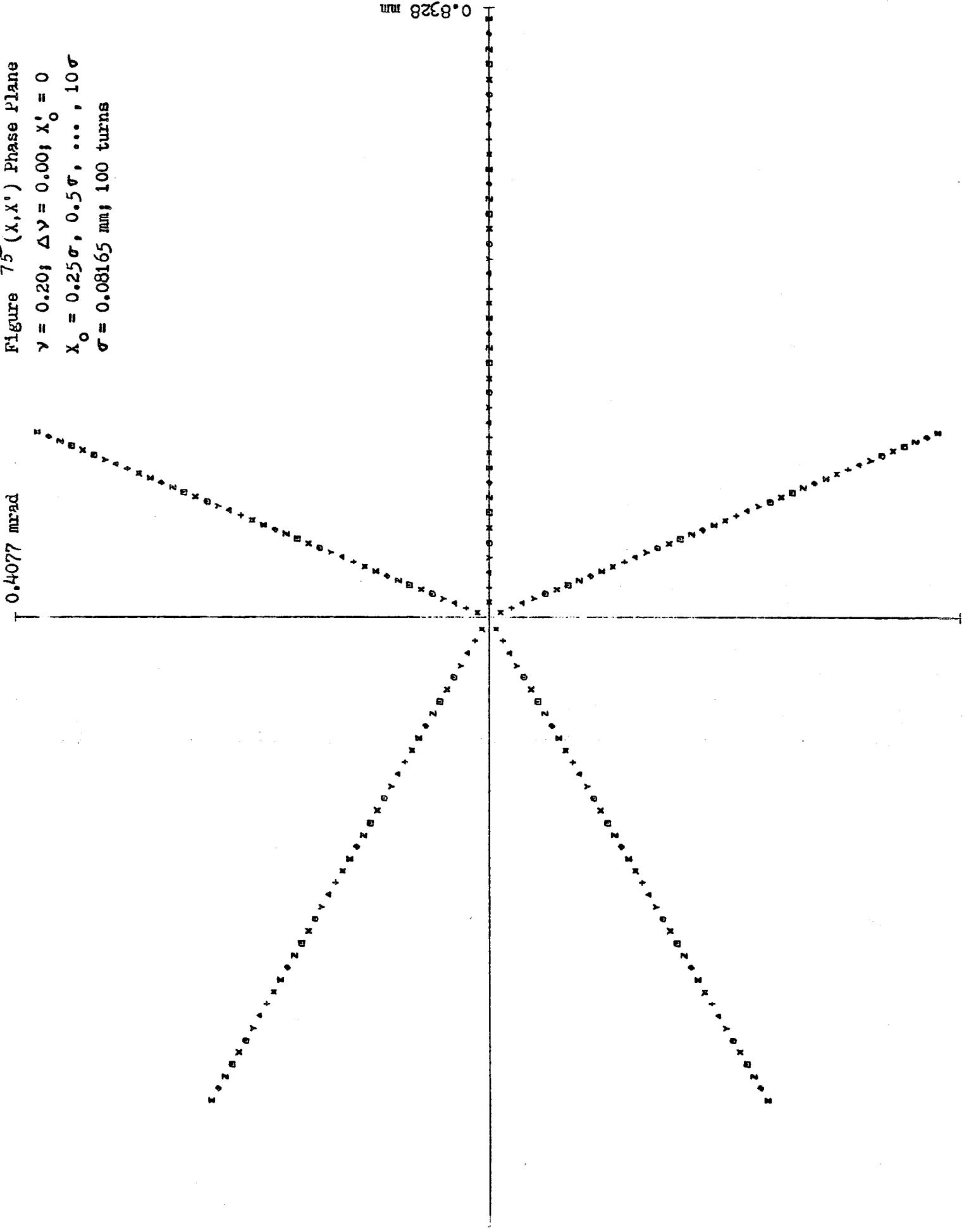


Figure 76
TM-1054

0.3281 mrad

Figure 76 (X, X') Phase Plane

$V = 0.15; \Delta V = 0.10$

100 turns

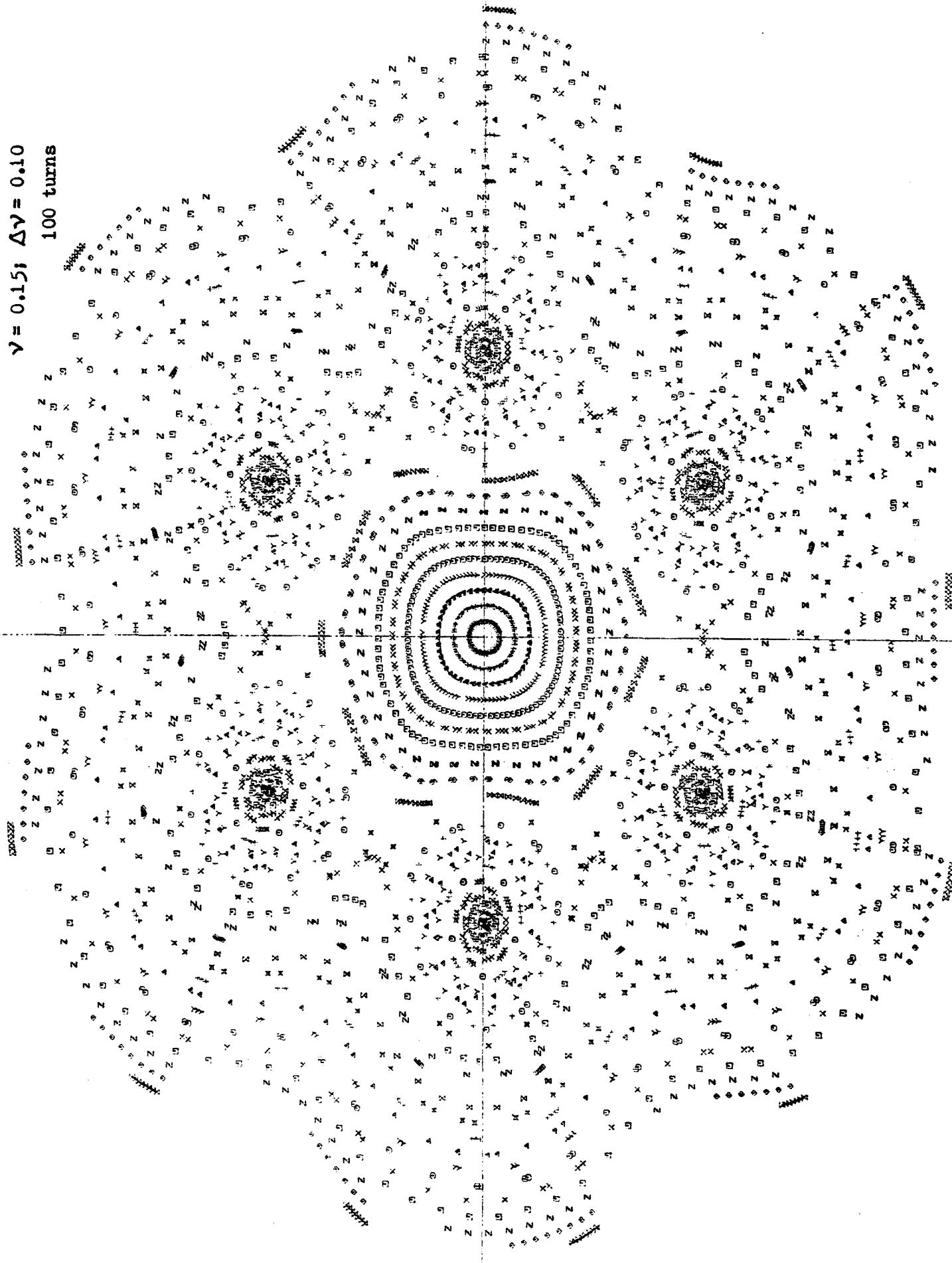
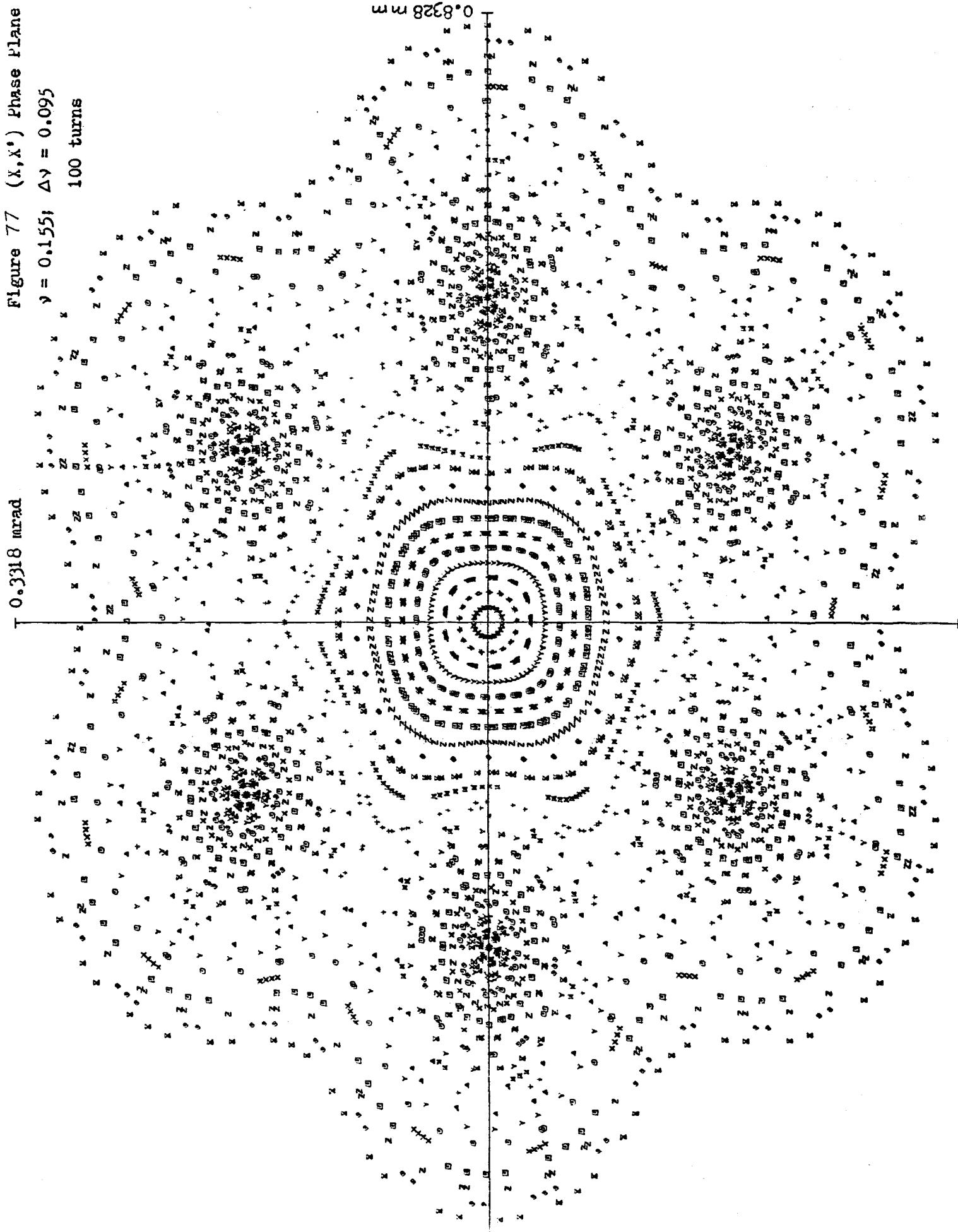


Figure 77
TM-1054



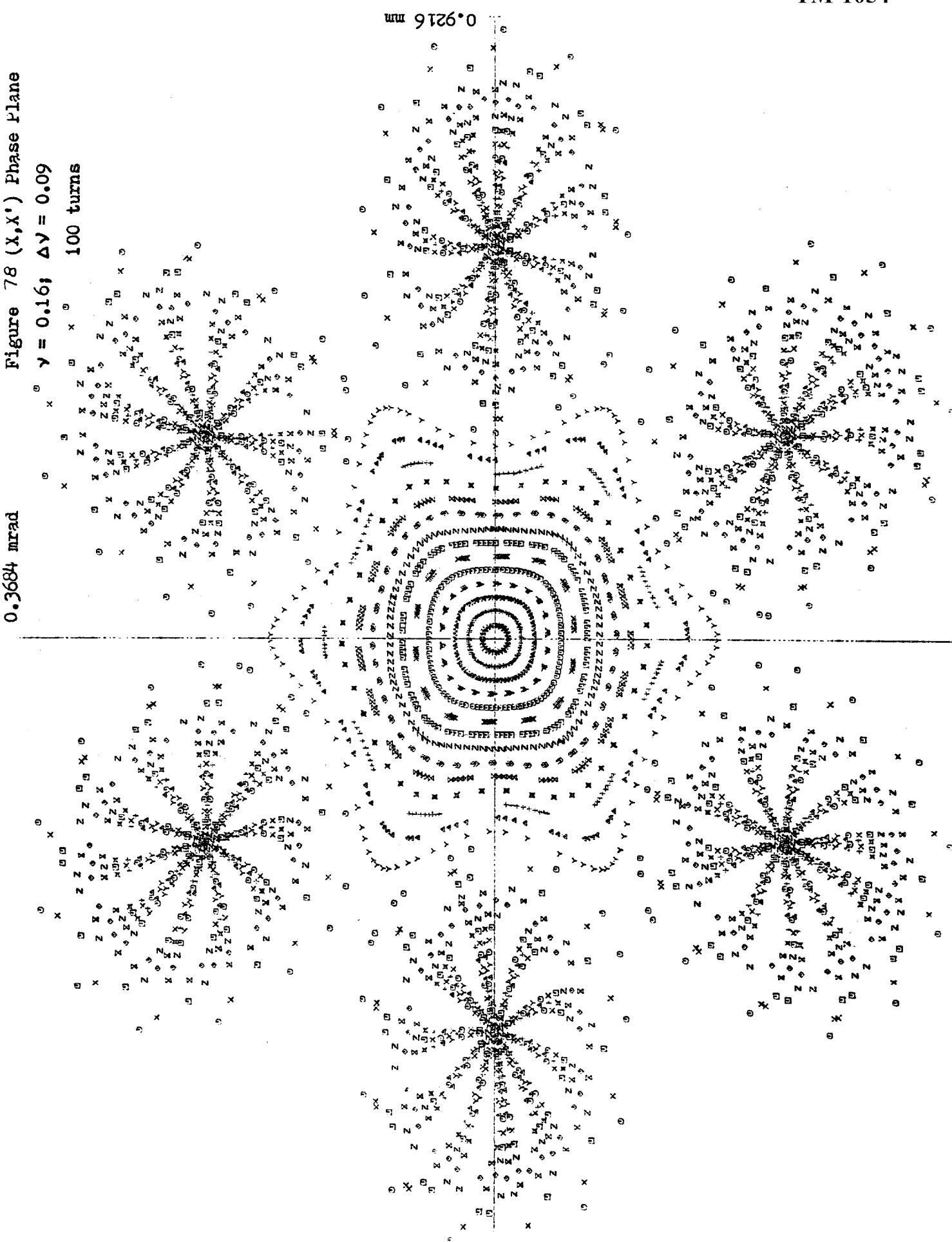


Figure 79
TM-1054

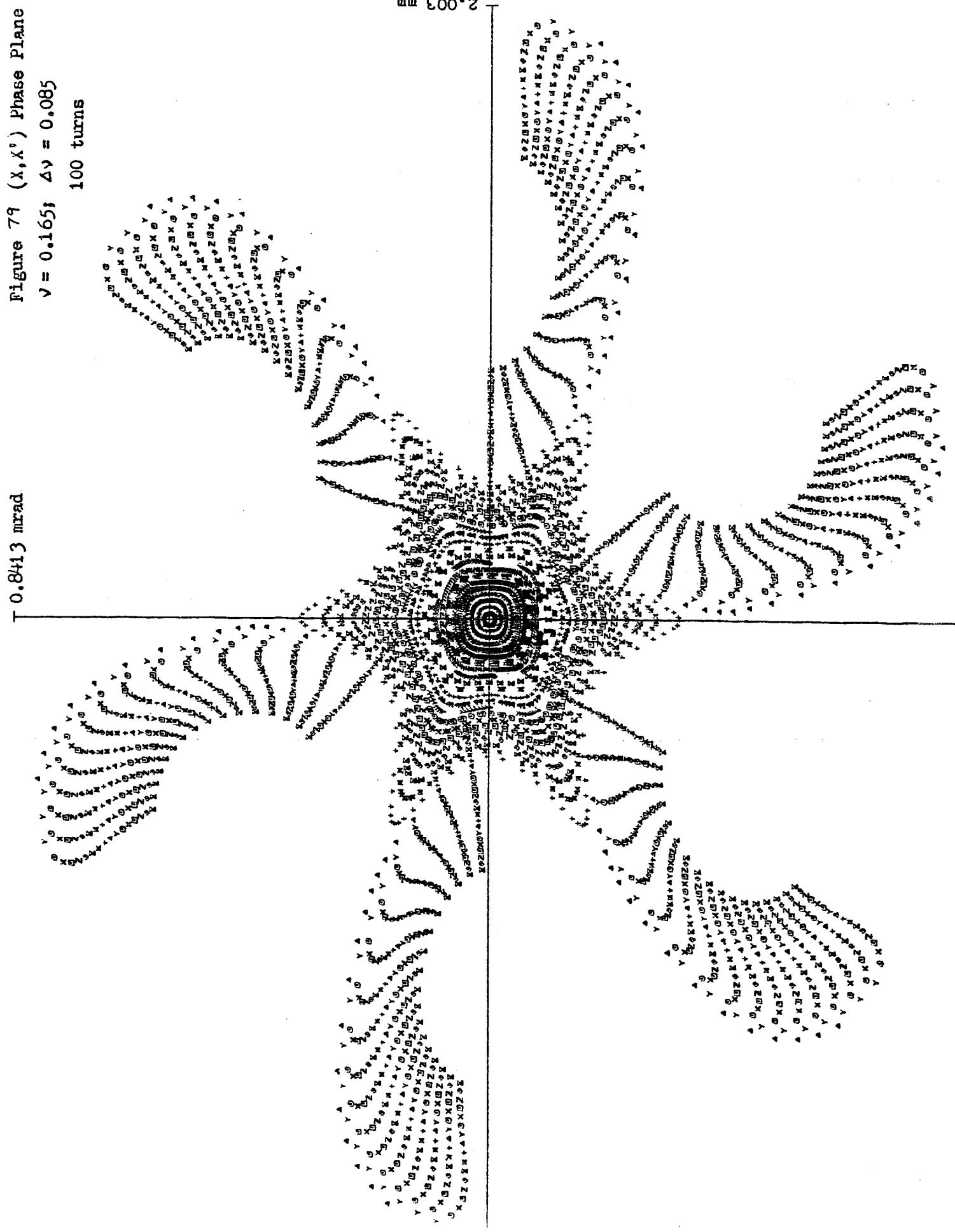


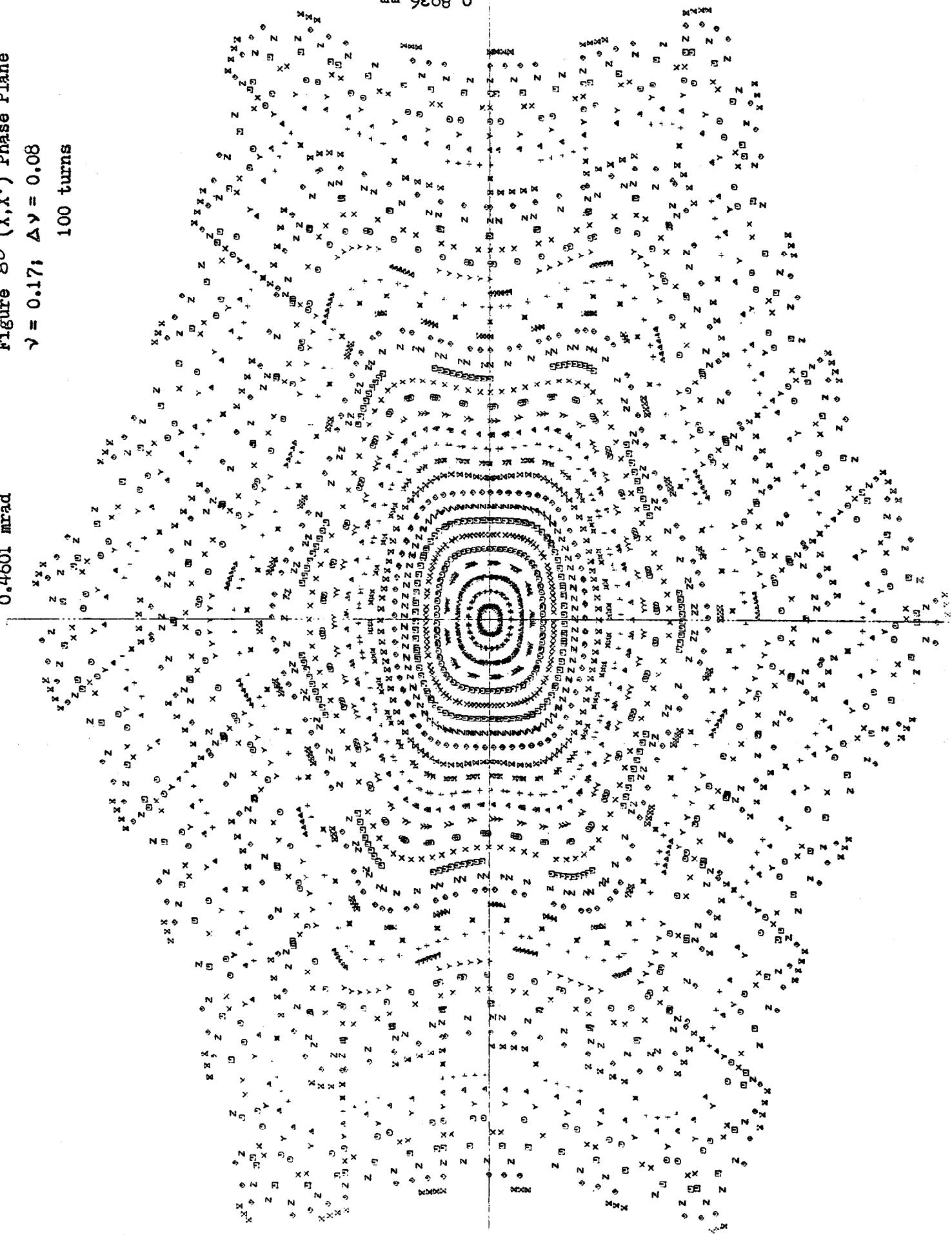
Figure 80
TM-1054

0.4601 mrad Figure 80 (X, X') Phase Plane

$\gamma = 0.17; \Delta\gamma = 0.08$

100 turns

0.8936 mm



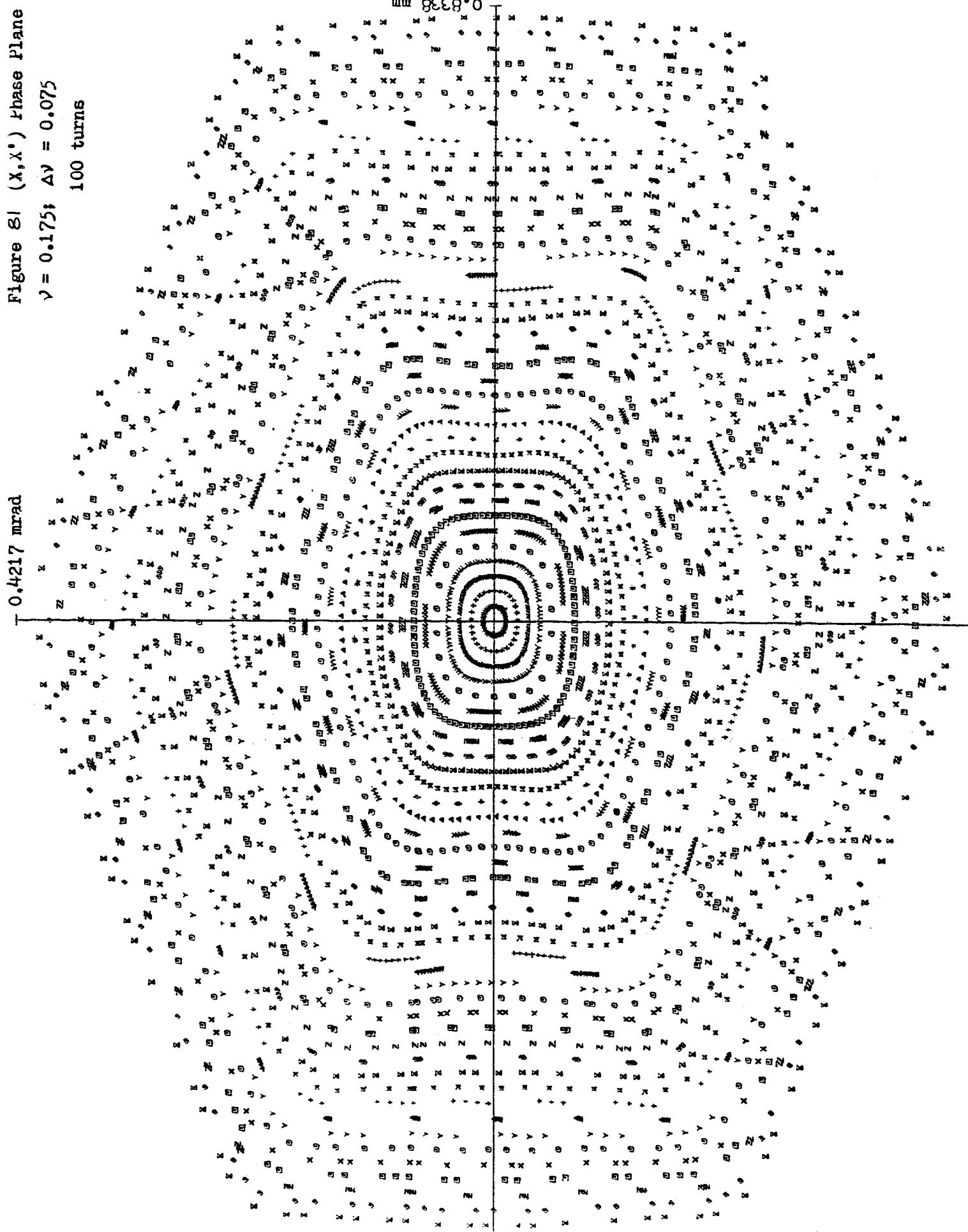


Figure 82
TM-1054

0.4262 mrad

Figure 82 (X, X') Phase Plane

$\nu = 0.18$, $\Delta\nu = 0.07$

100 turns

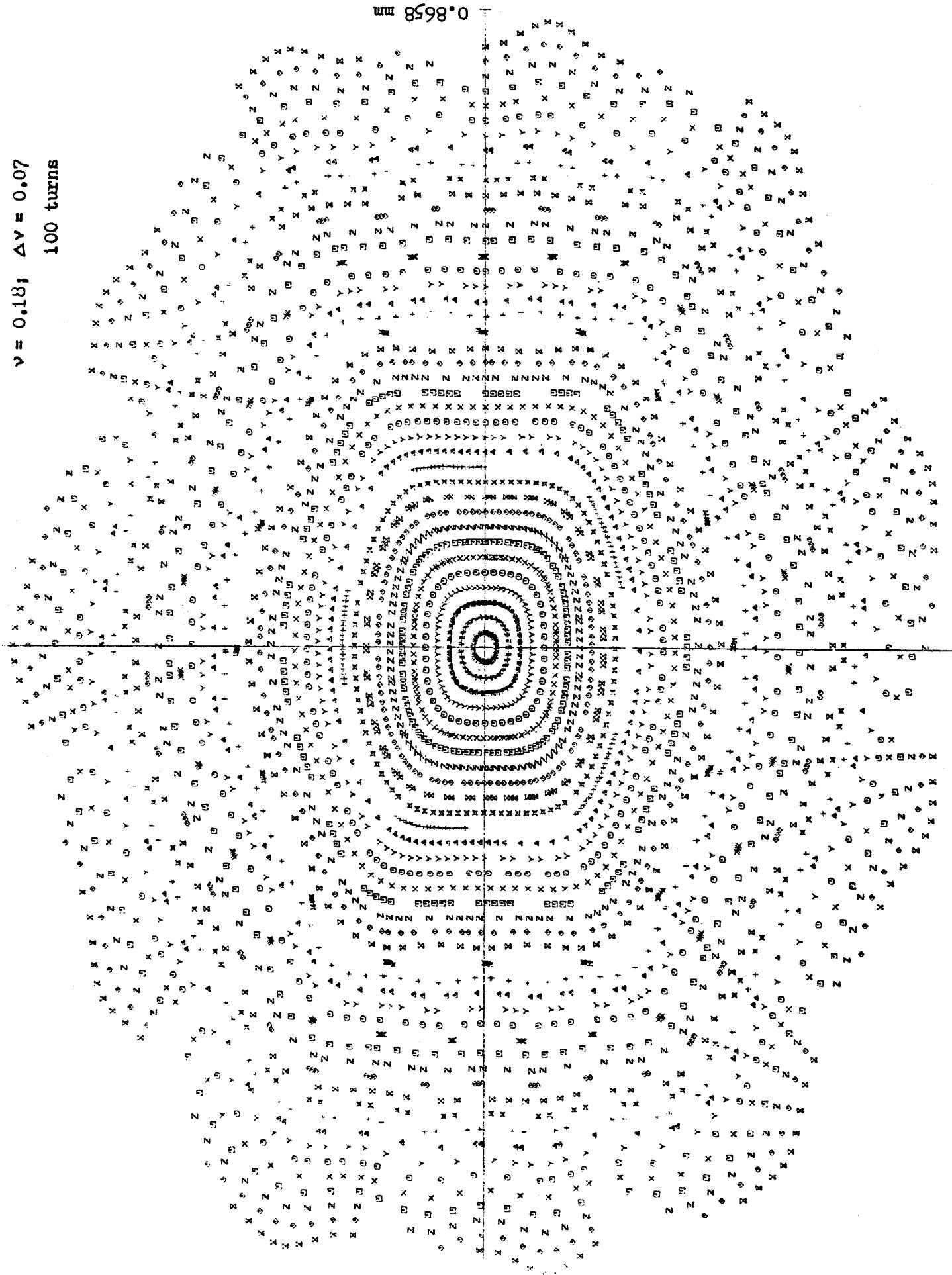


Figure 83
TM-1054

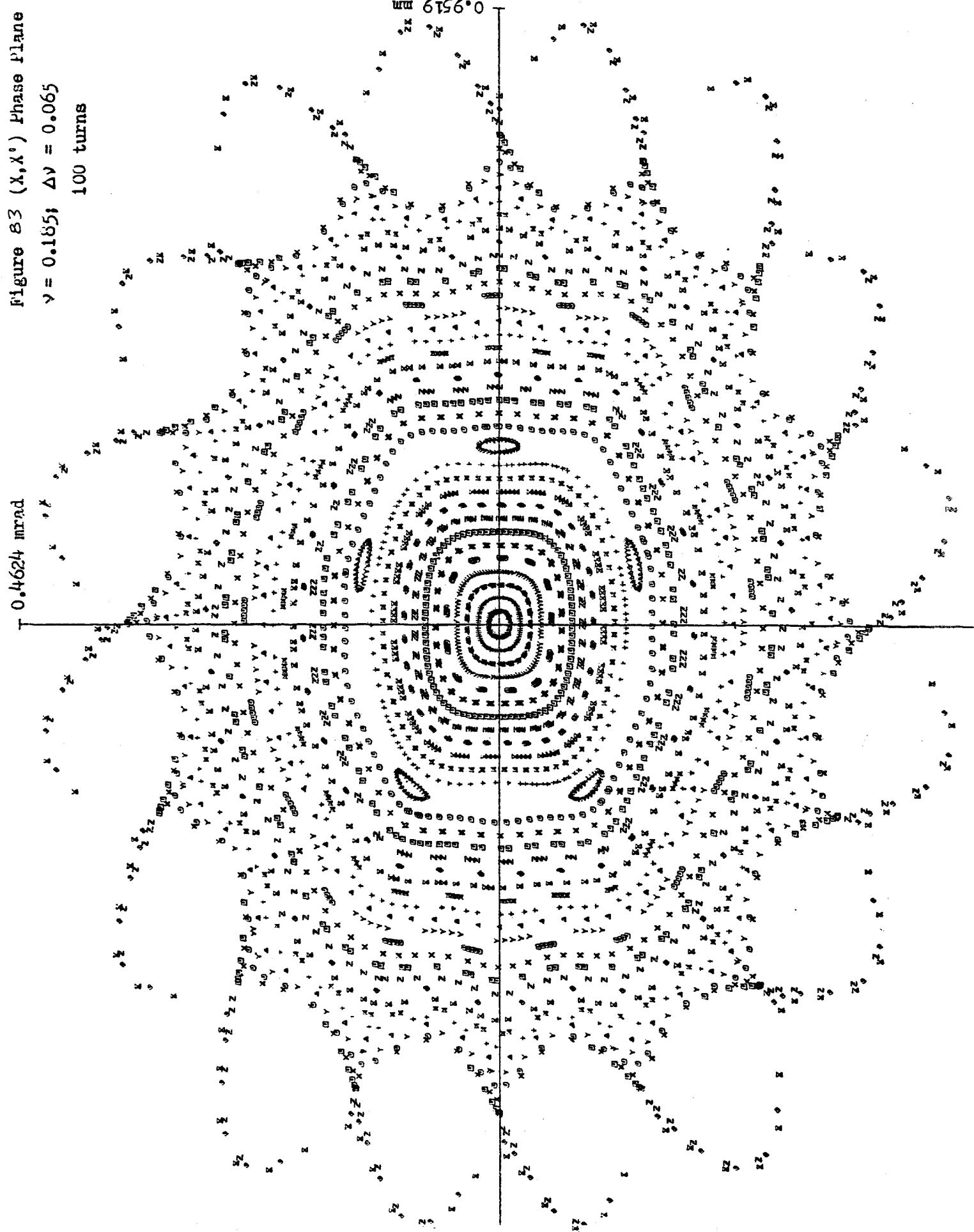


Figure 84

TM-1054

0.3968 mrad

Figure 84 (λ, λ°) Phase Plane

$v = 0.19$; $\Delta v = 0.06$

100 turns

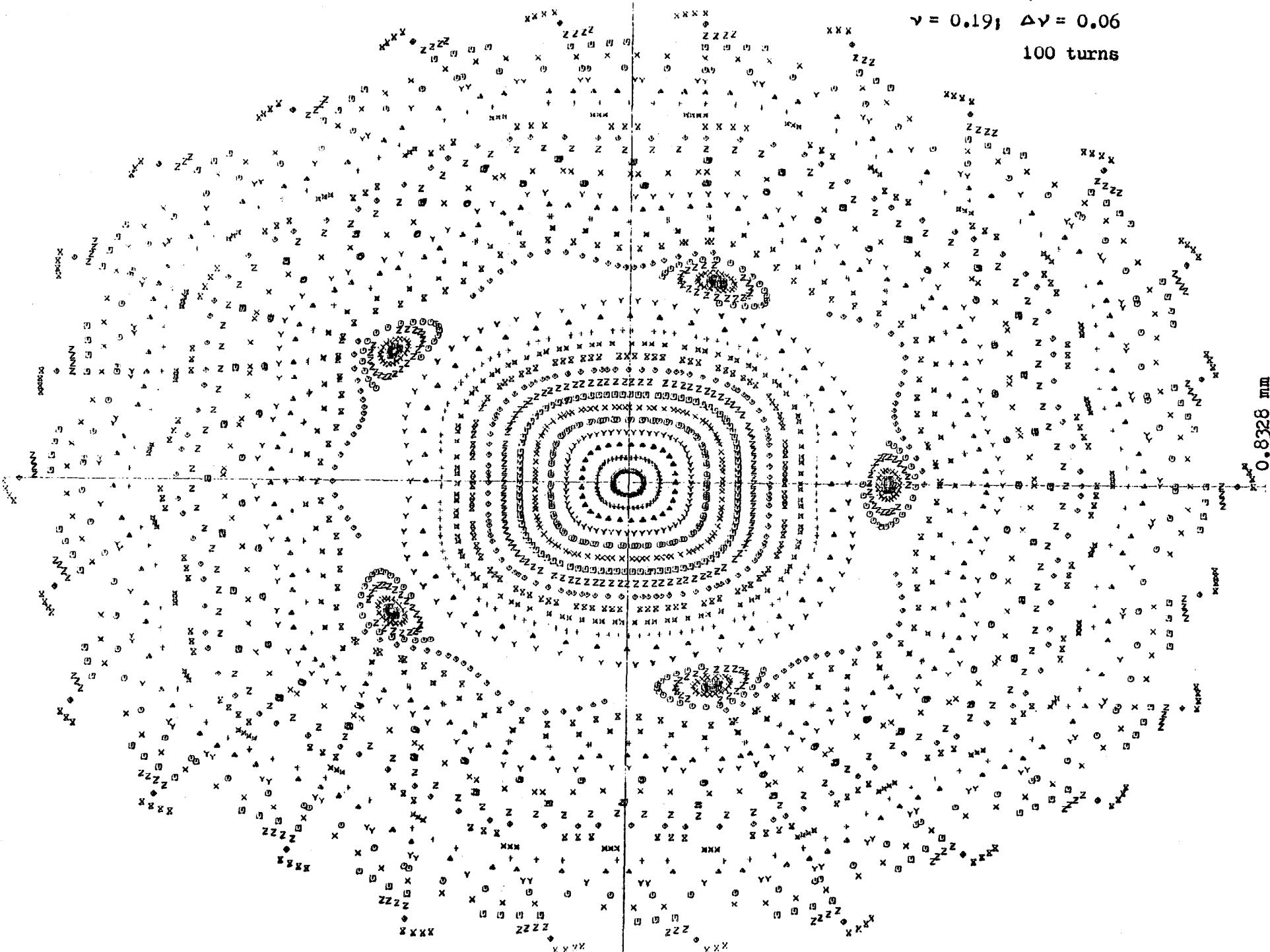


Figure 85

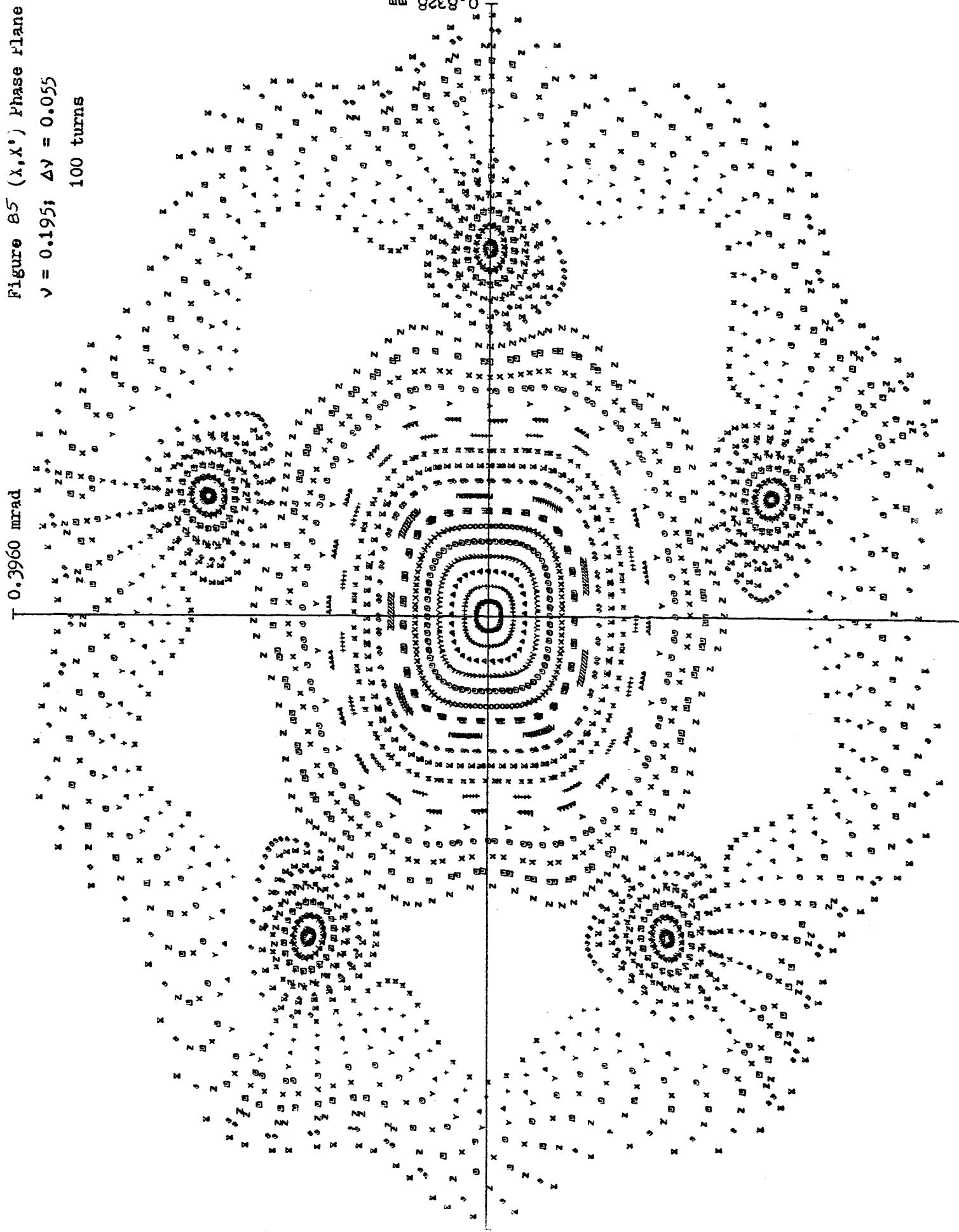


Figure 86 (λ, λ') Phase Plane 0.4889 mrad $V = 0.201, \Delta V = 0.05$

100 turns

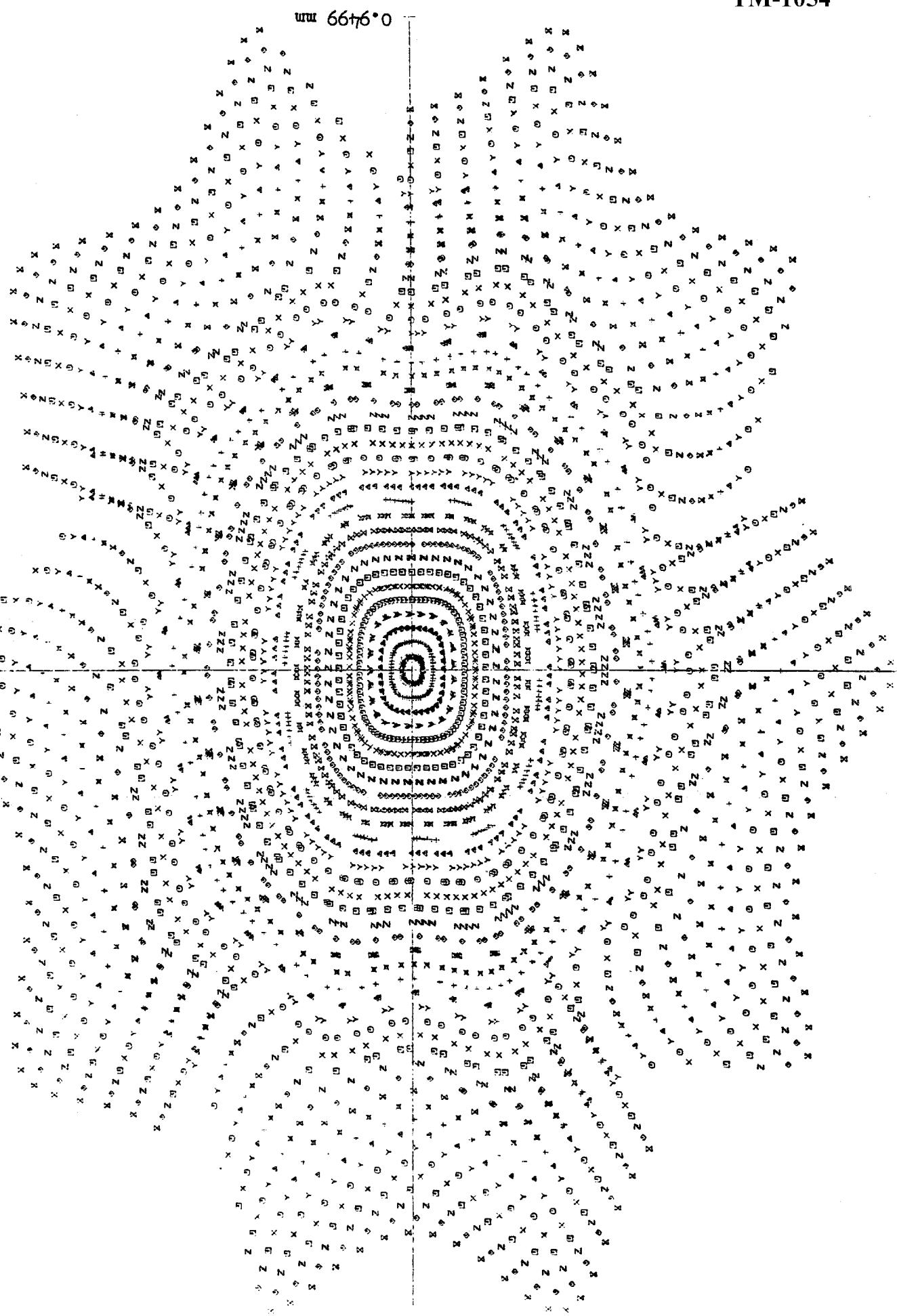


Figure 87 (X, X') Phase Plane

$\gamma = 0.2051$ $\Delta v = 0.045$

100 turns

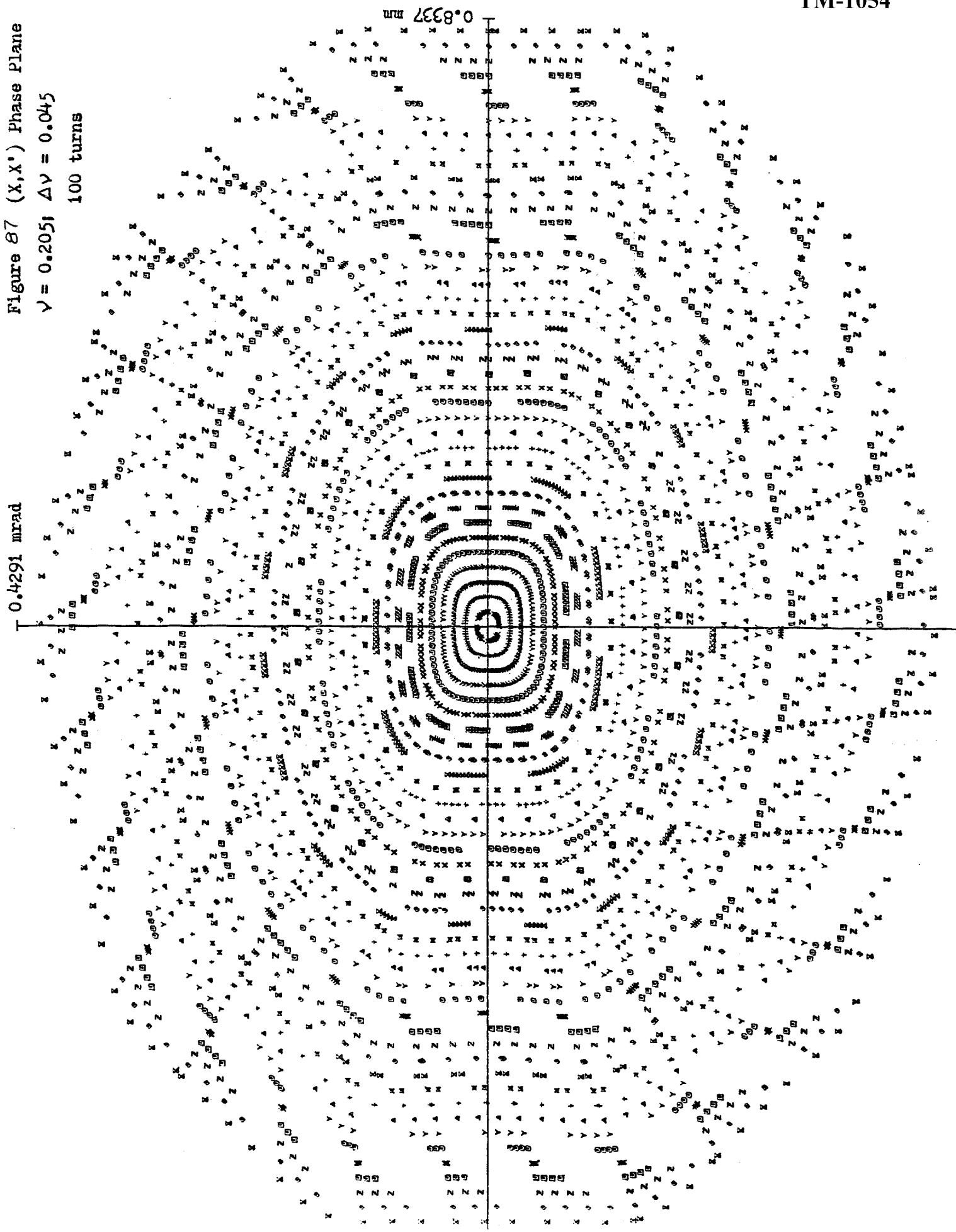


Figure 88
TM-1054

Figure 88 (X, X') Phase Plane

$V = 0.21; \Delta V = 0.04$

100 turns

0.4174 mrad

0.08328 mm

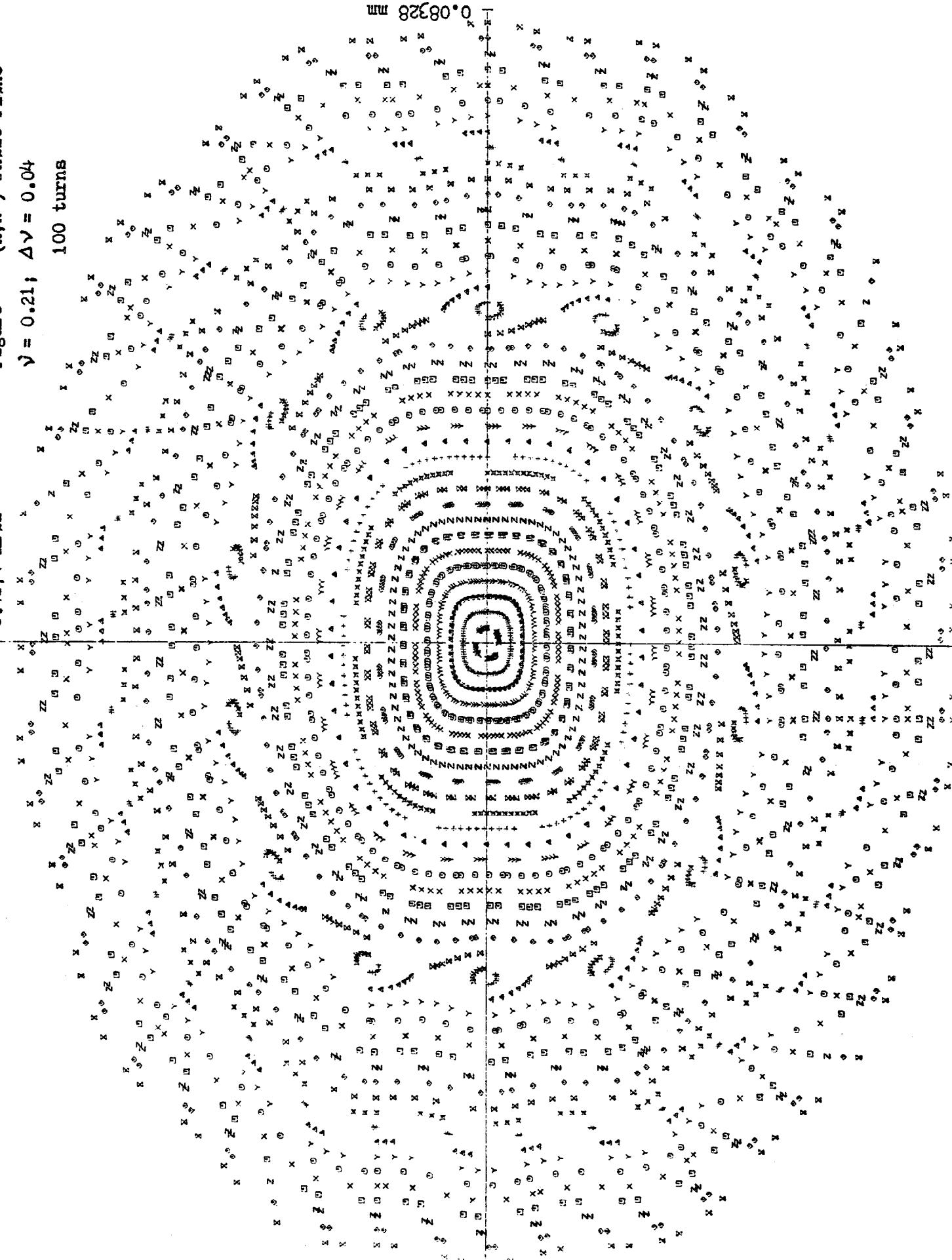


Figure 89
TM-1054

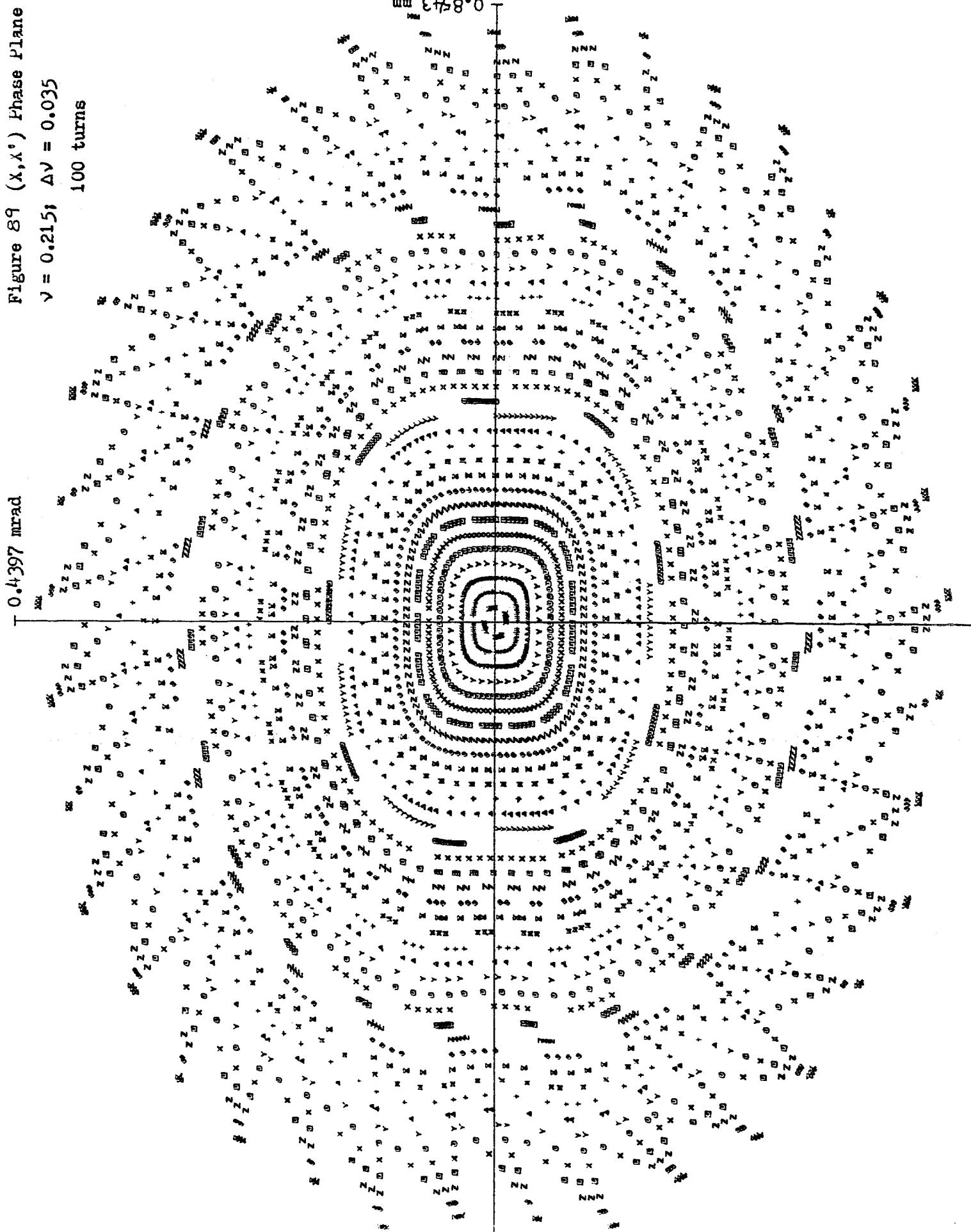


Figure 90
TM-1054

Figure 90 (X, X') Phase Plane

$\psi = 0.22; \Delta\gamma = 0.03$

100 turns

0.4240 mrad

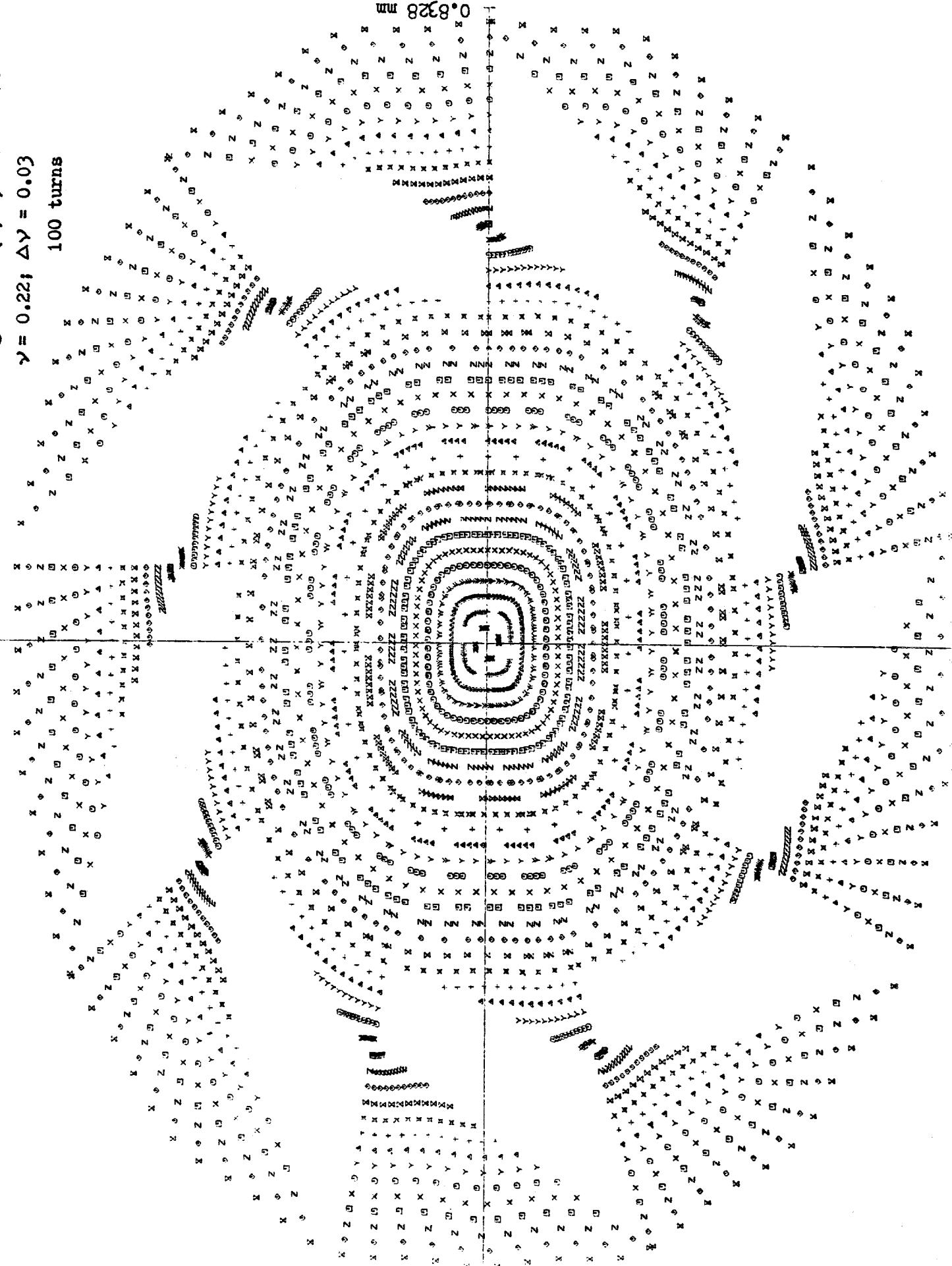


Figure 91

TM-1054

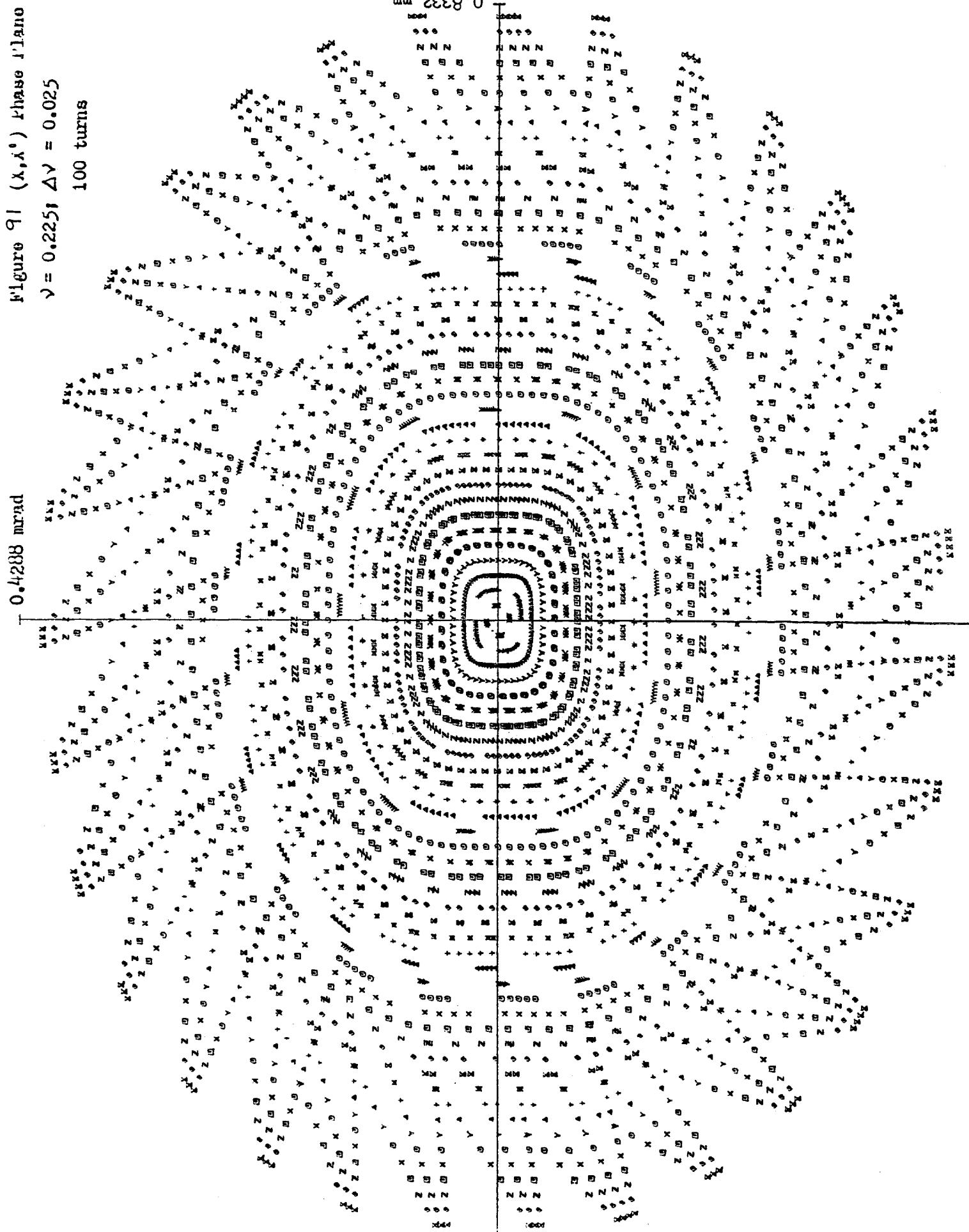


Figure 92
TM-1054

Figure 92 (X, λ') Phase Plane

$\gamma = 0.23; \Delta \nu = 0.02$

100 turns

0.4270 mrad

Z

Y

X

0.08328 mm

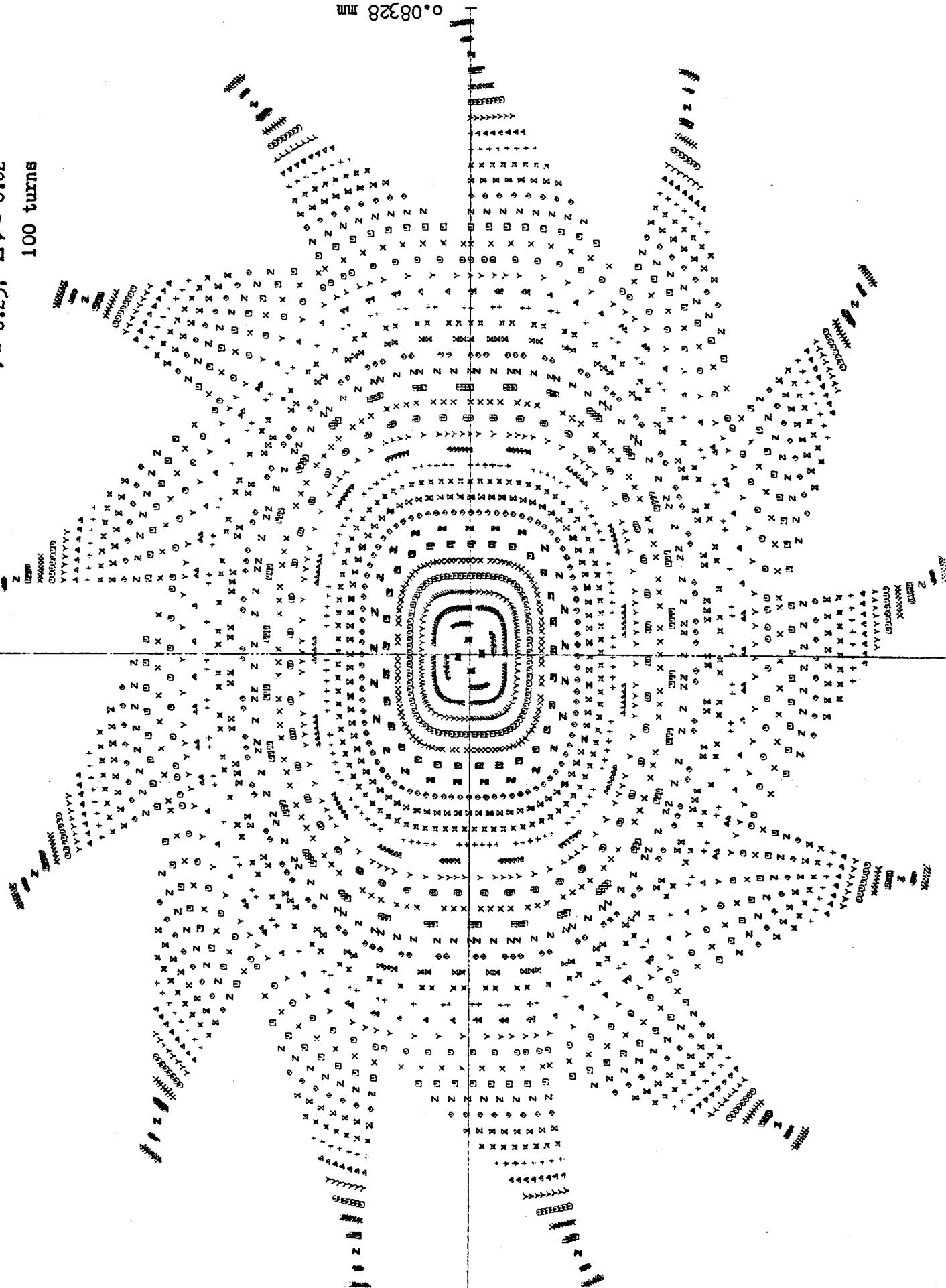


Figure 93
TM-1054

Figure 93 (X, X') Phase Plane

$\gamma = 0.235; \Delta\gamma = 0.015$

100 turns

$T = 0.4290 \text{ mrad}$

0.8335 mm

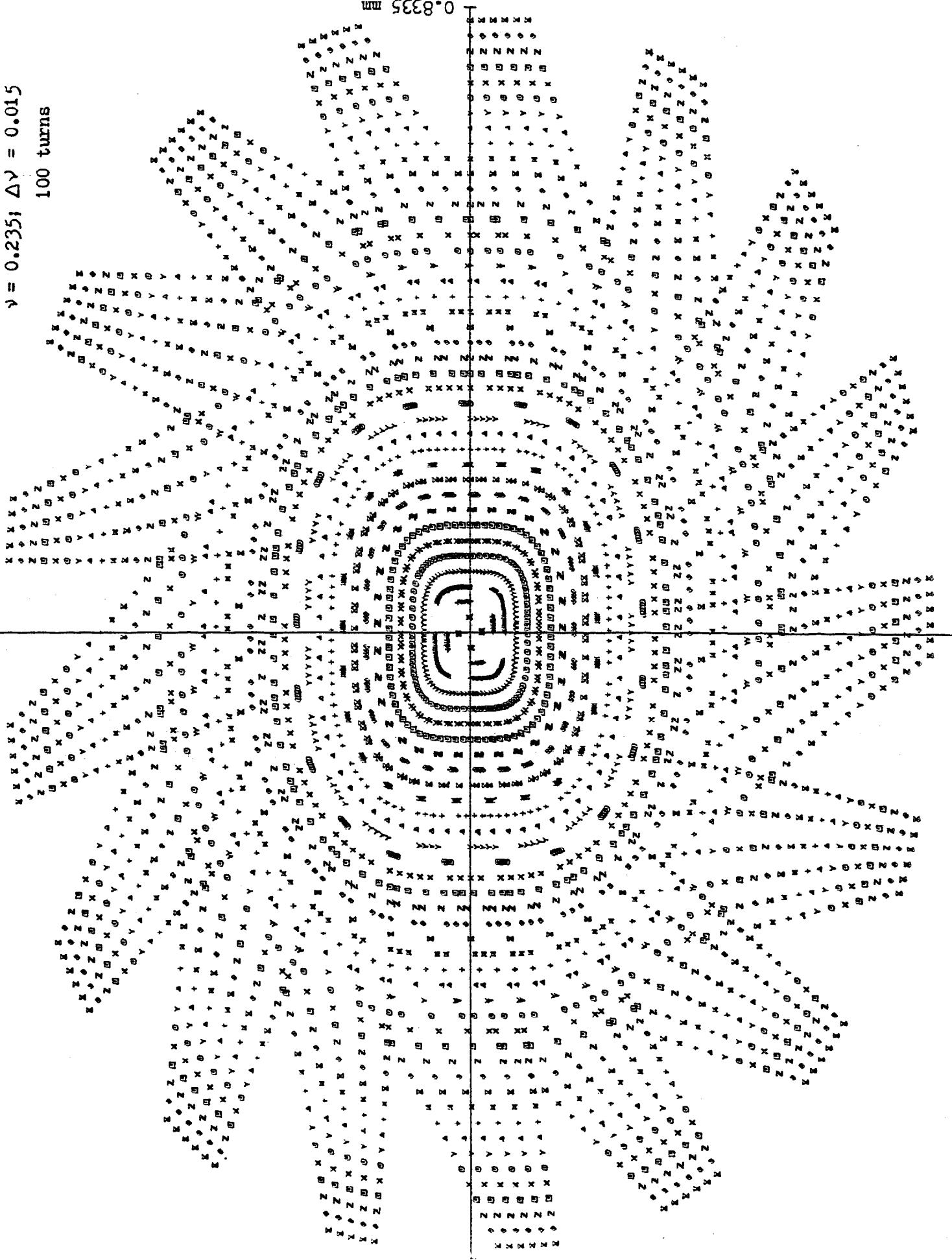


Figure 94
TM-1054

Figure 94 (X, X') Phase Plane

$\nu = 0.24$; $\Delta\nu = 0.01$

100 turns

0.4287 mrad

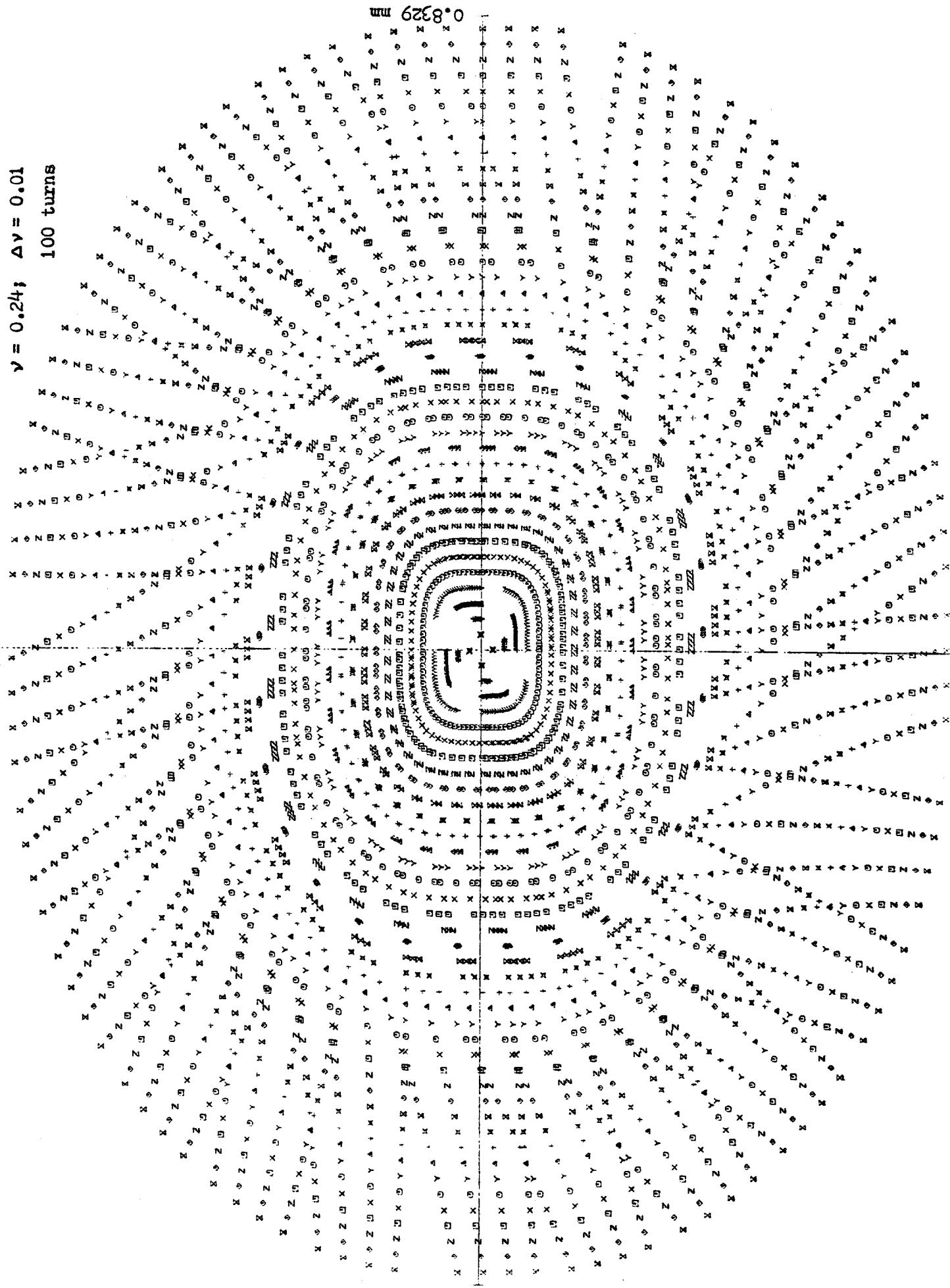
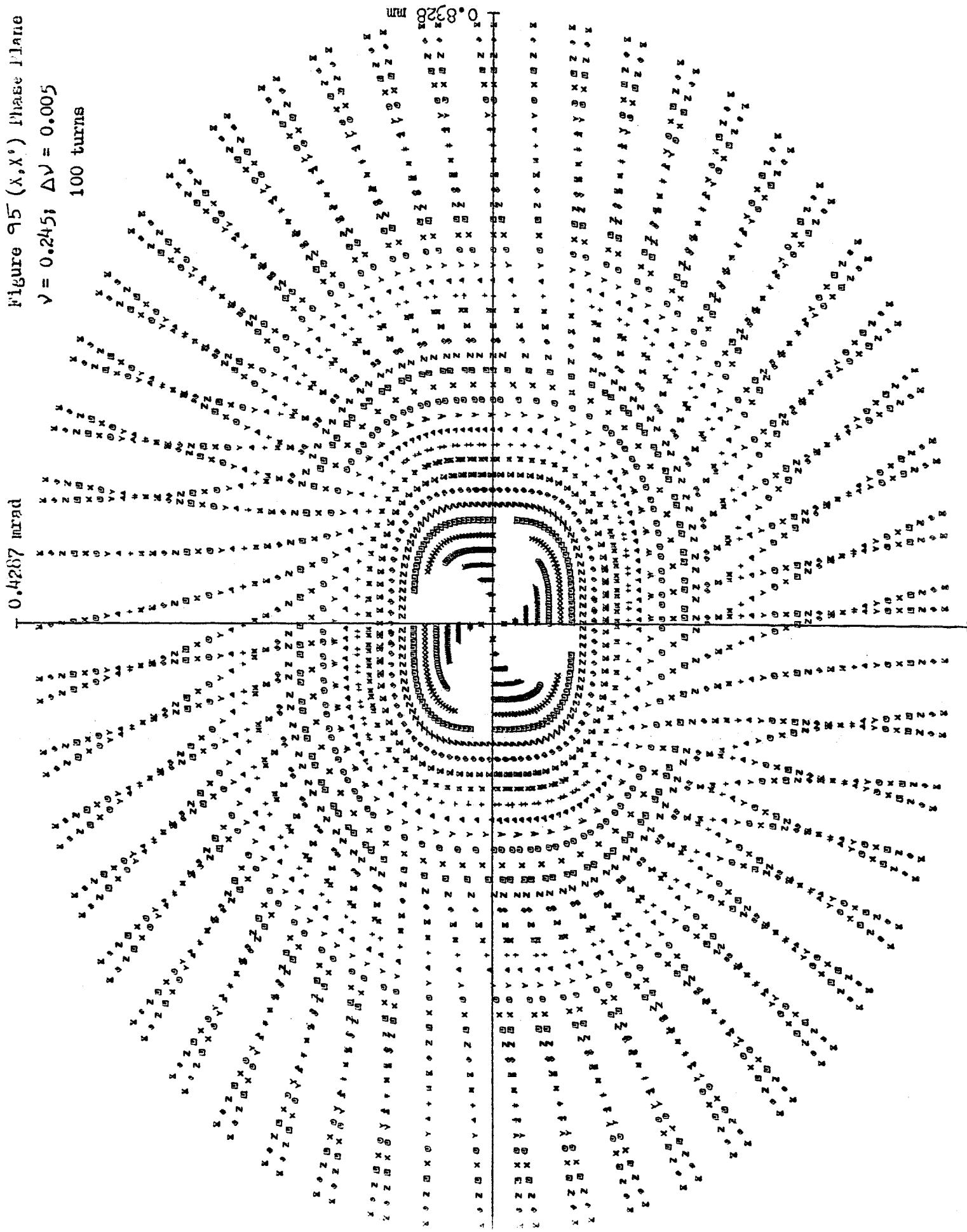


Figure 95
TM-1054

Figure 95⁻ (λ, λ') Phase Line

$\gamma = 0.245; \Delta\lambda = 0.005$

100 turns



0.828 mm

Figure 96 (X, X') Phase Plane $\gamma = 0.25; \Delta \gamma = 0.00; X_0^* = 0$ $X_0 = 0.25\sigma, 0.5\sigma, \dots, 10\sigma$ $\sigma = 0.08165 \text{ mm}; 100 \text{ turns}$

0.4237 mrad

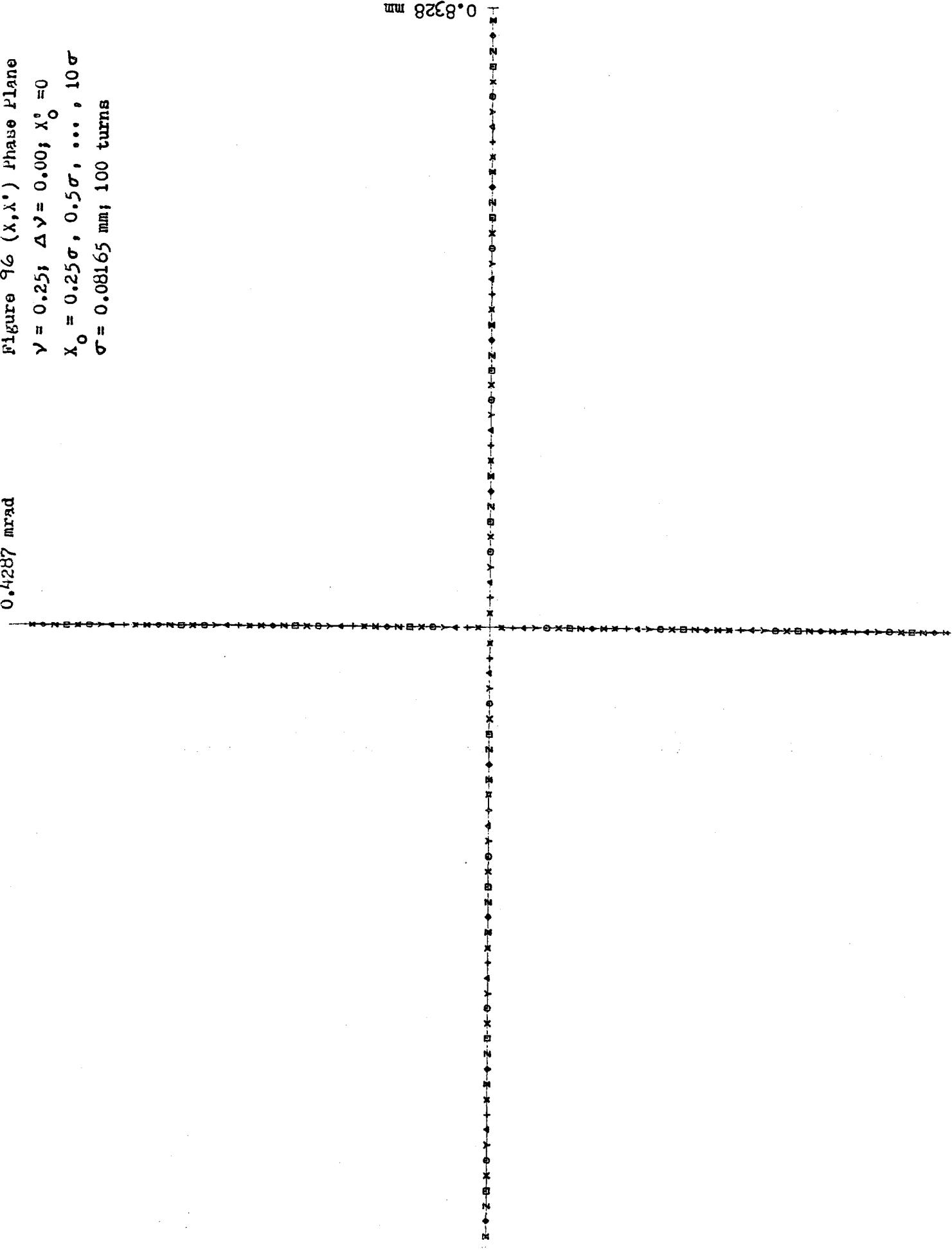


Figure 97
TM-1054

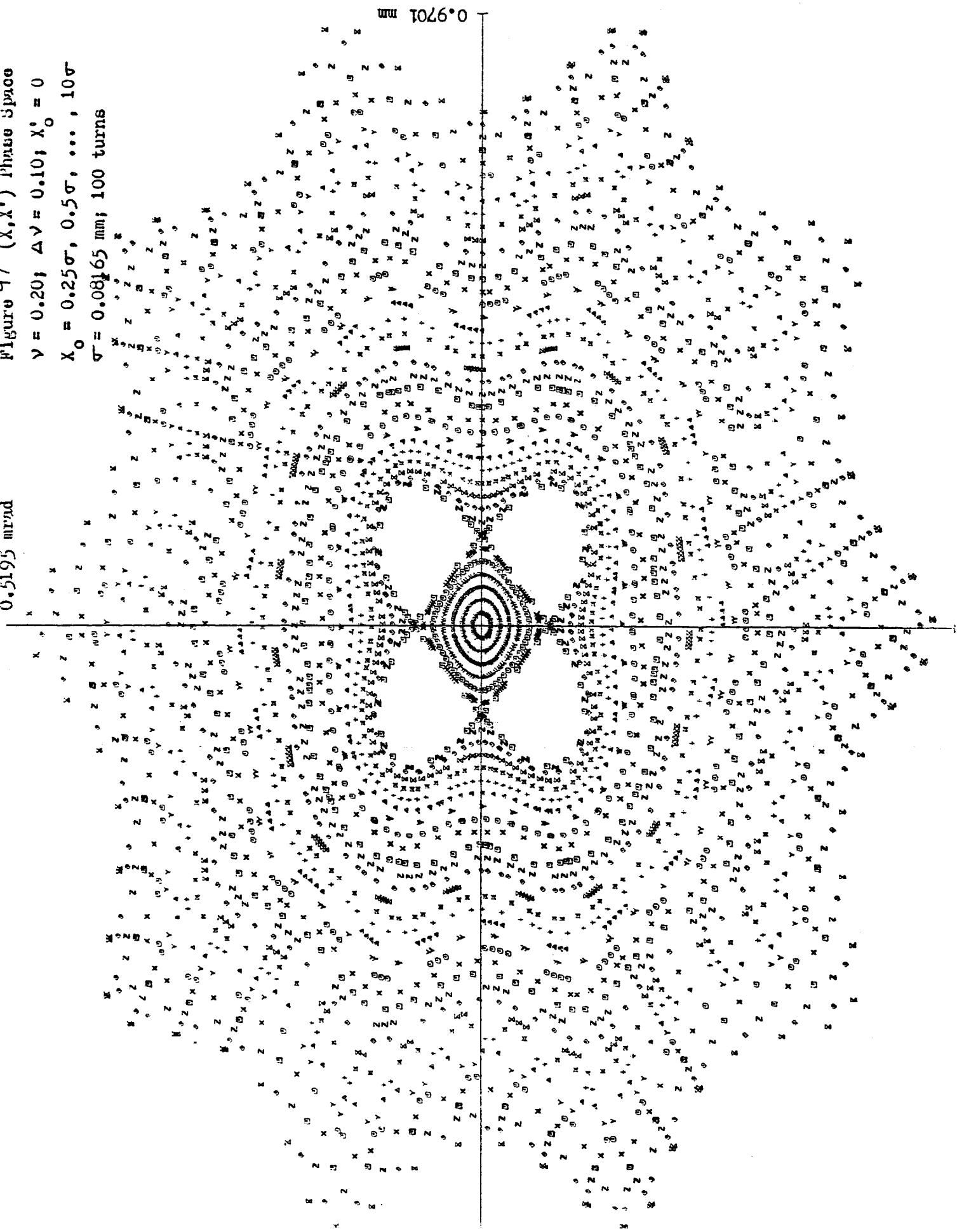
Figure 97 (χ, χ') Phase Space

$\gamma = 0.20$; $\Delta\gamma = 0.10$; $\chi'_0 = 0$

$\chi_0 = 0.25\sigma, 0.5\sigma, \dots, 10\sigma$

$\sigma = 0.08165$ mm; 100 turns

0.5195 mm

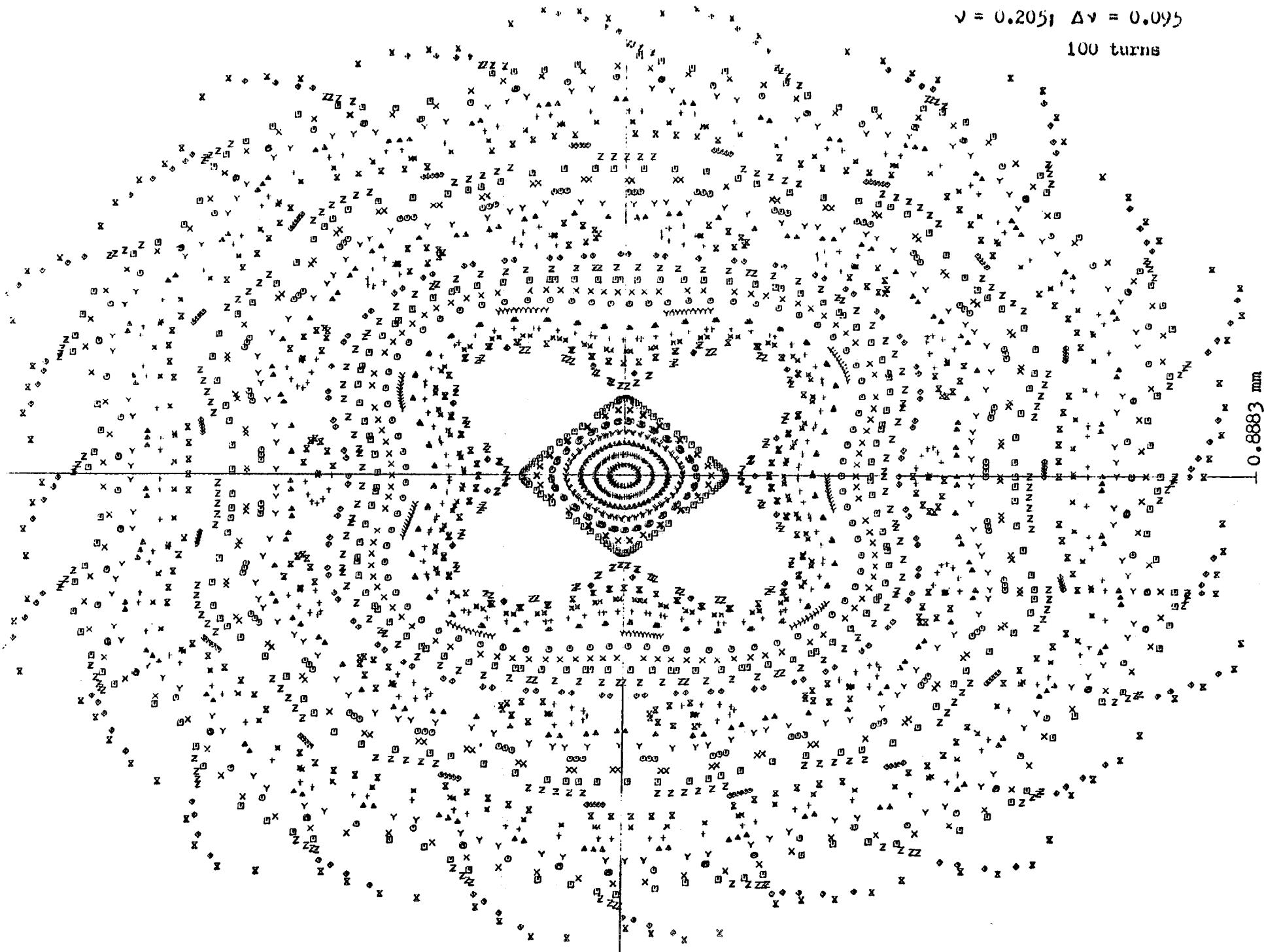


0.8883 mm

0.4/10 mrad

Figure 98 (λ, λ') Phase Plane $v = 0.2051$, $\Delta v = 0.095$

100 turns

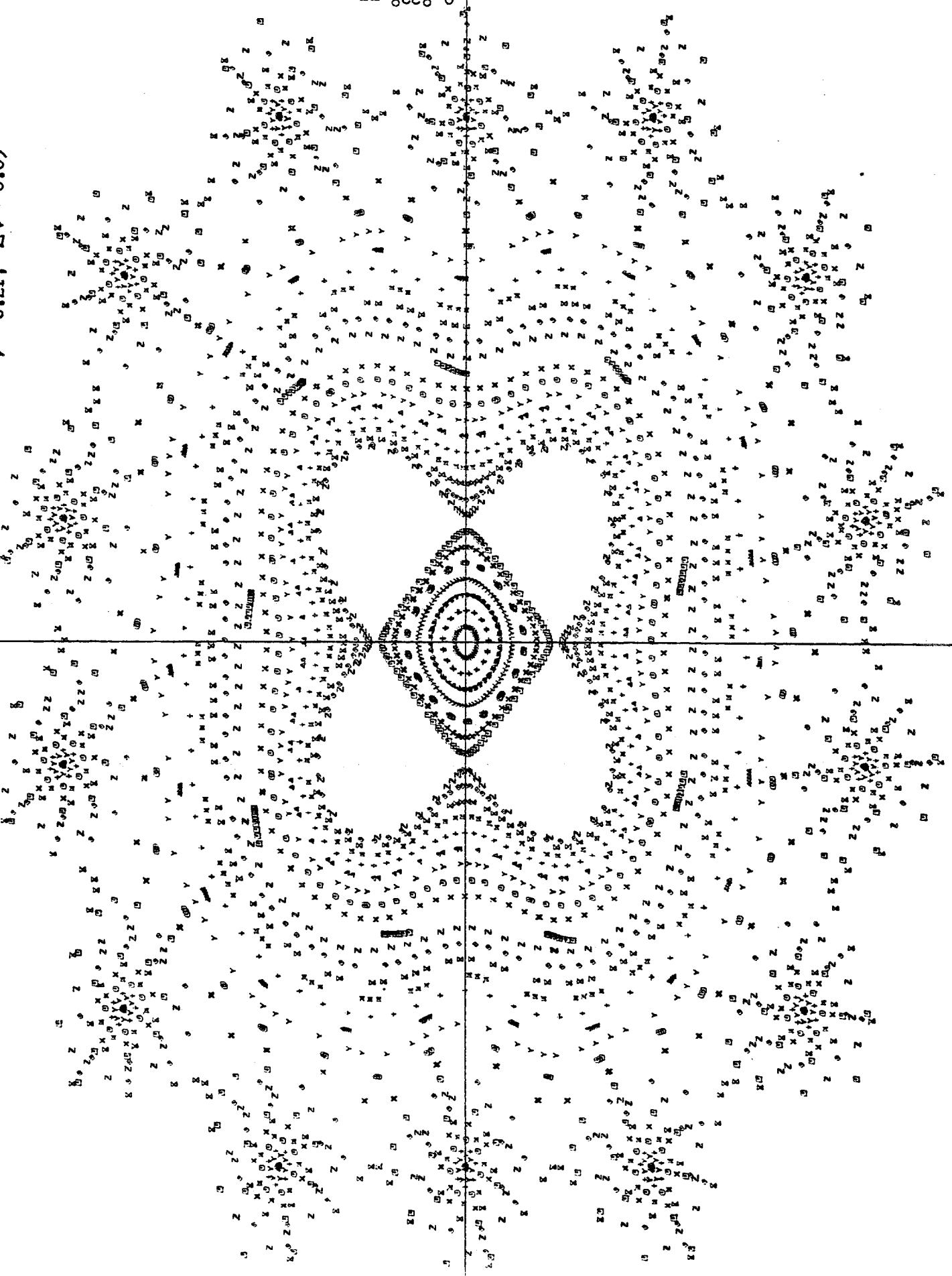


0.8328 mm

Figure 99(X, X') Phase Space

$\gamma = 0.21; \Delta\gamma = 0.09$

0.4427 mrad



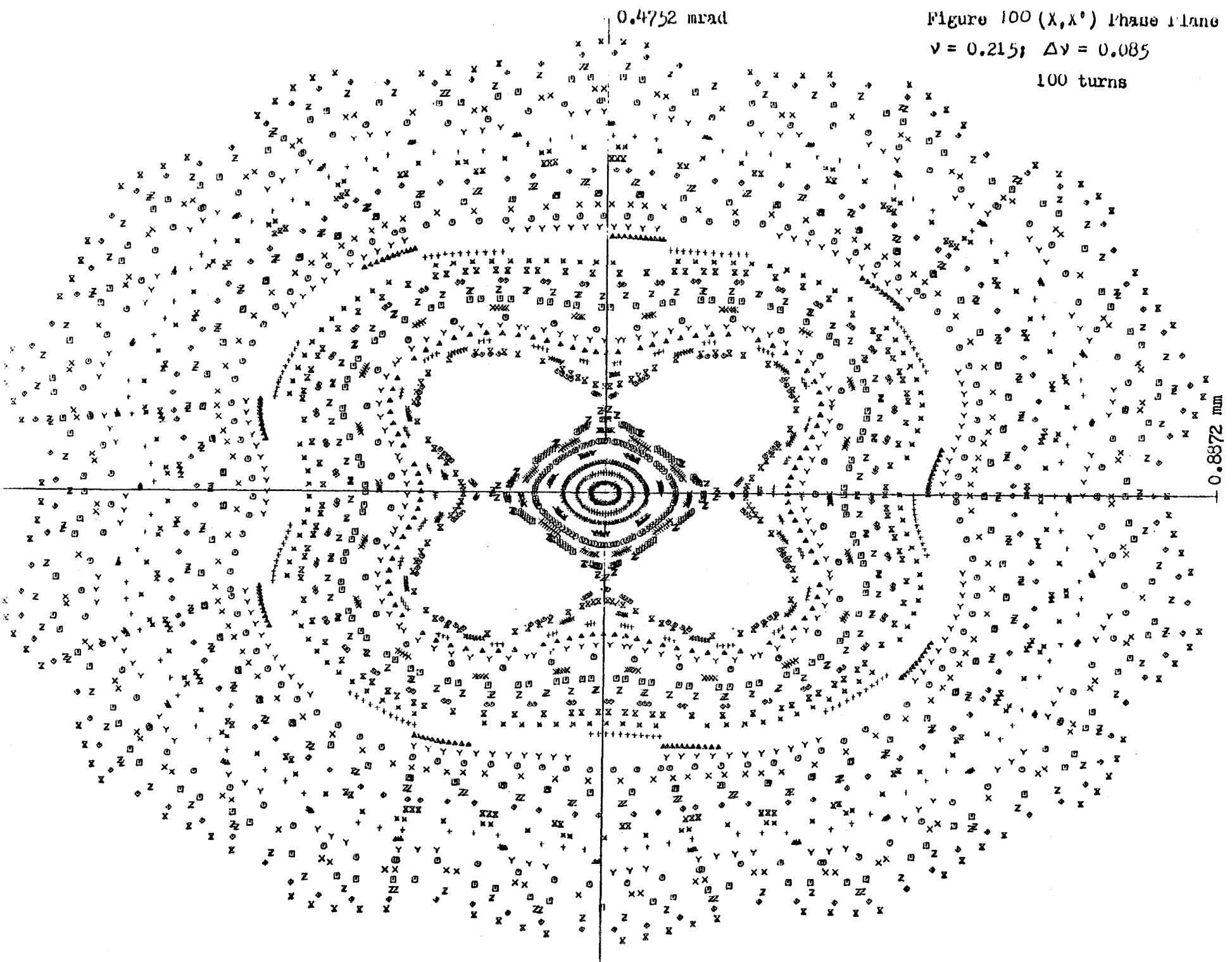


Figure 100
TM-1054

1.490 mm

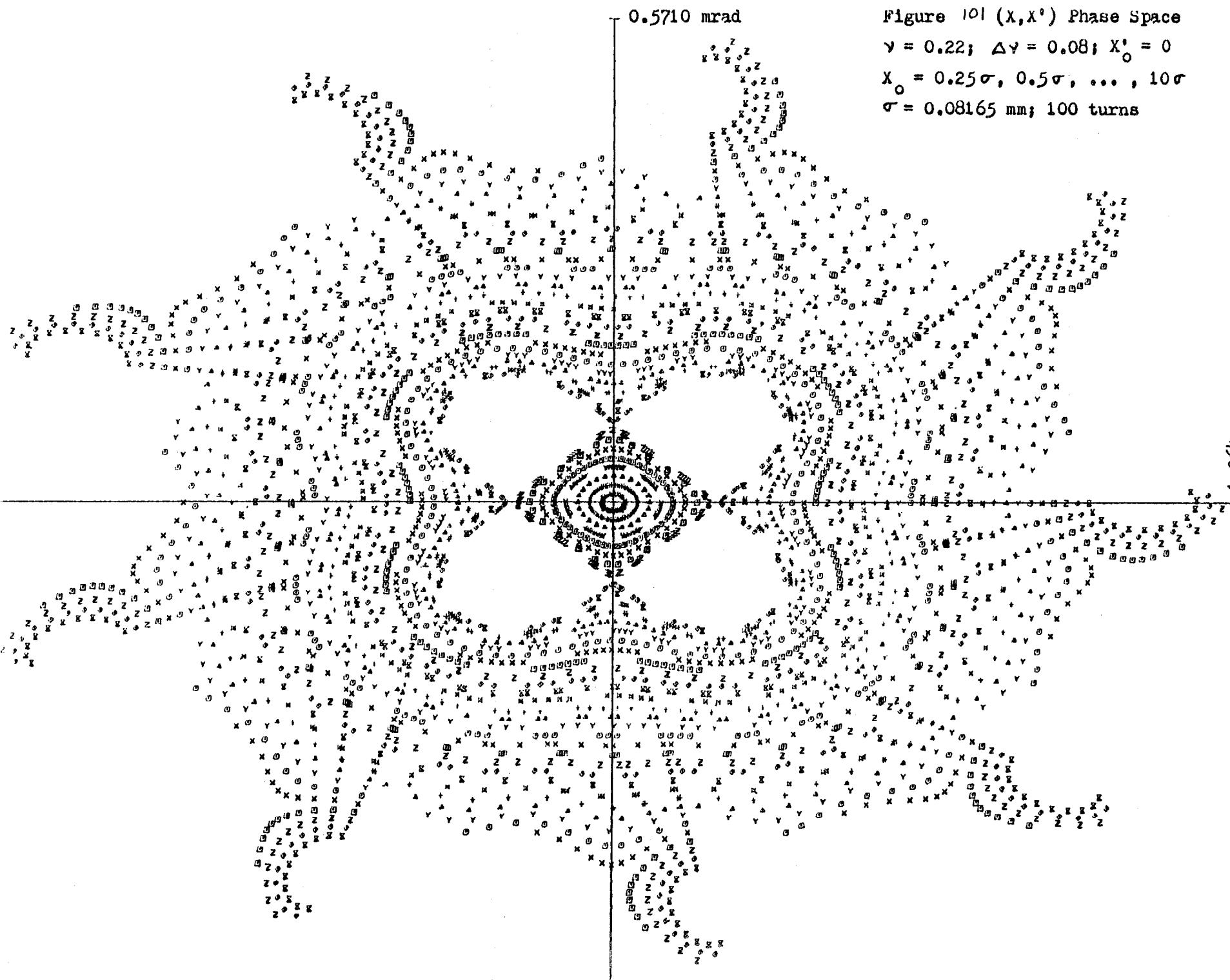


Figure 102
TM-1054

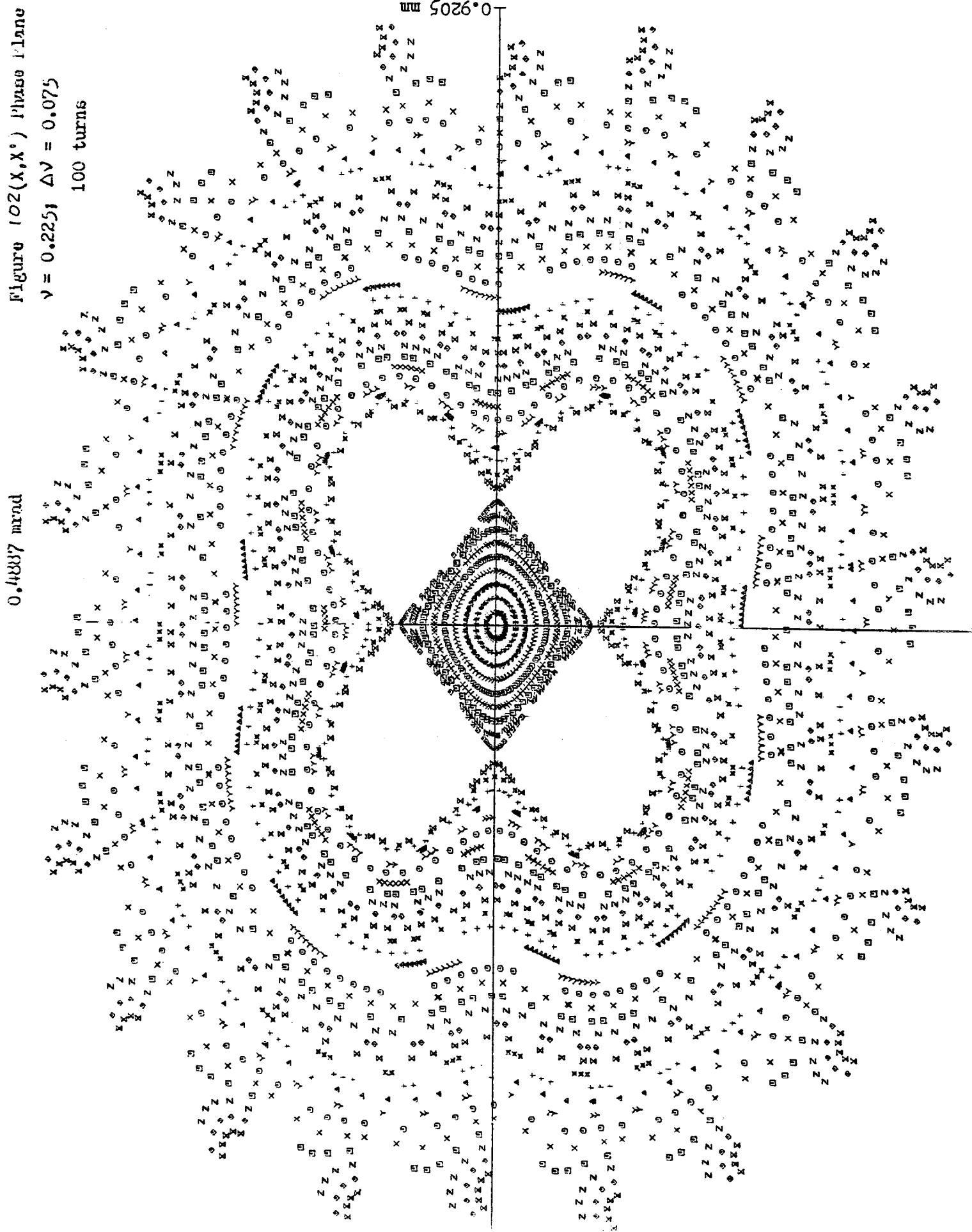


Figure 103(λ, λ') Phase Space

0.4651 mrad

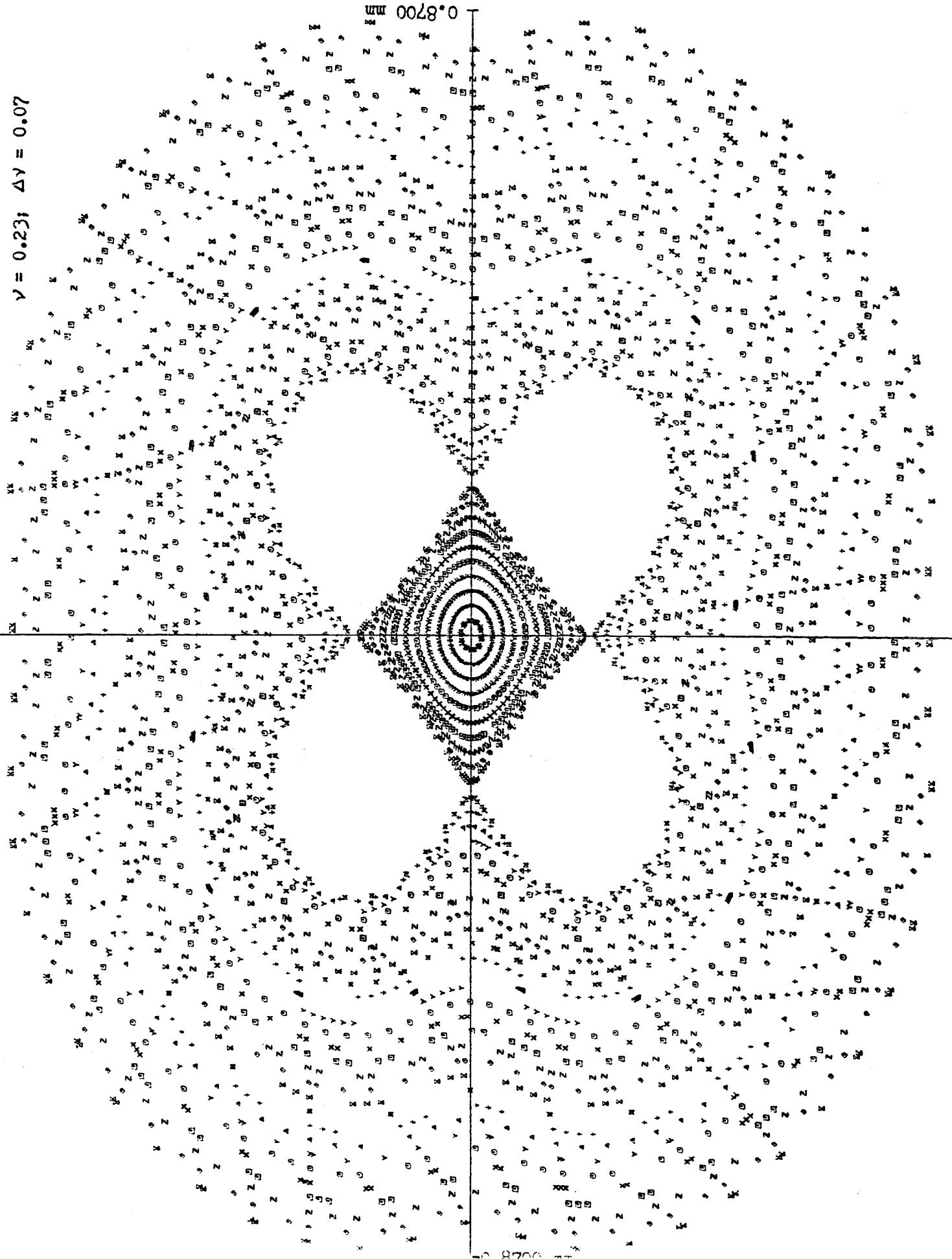


Figure 104

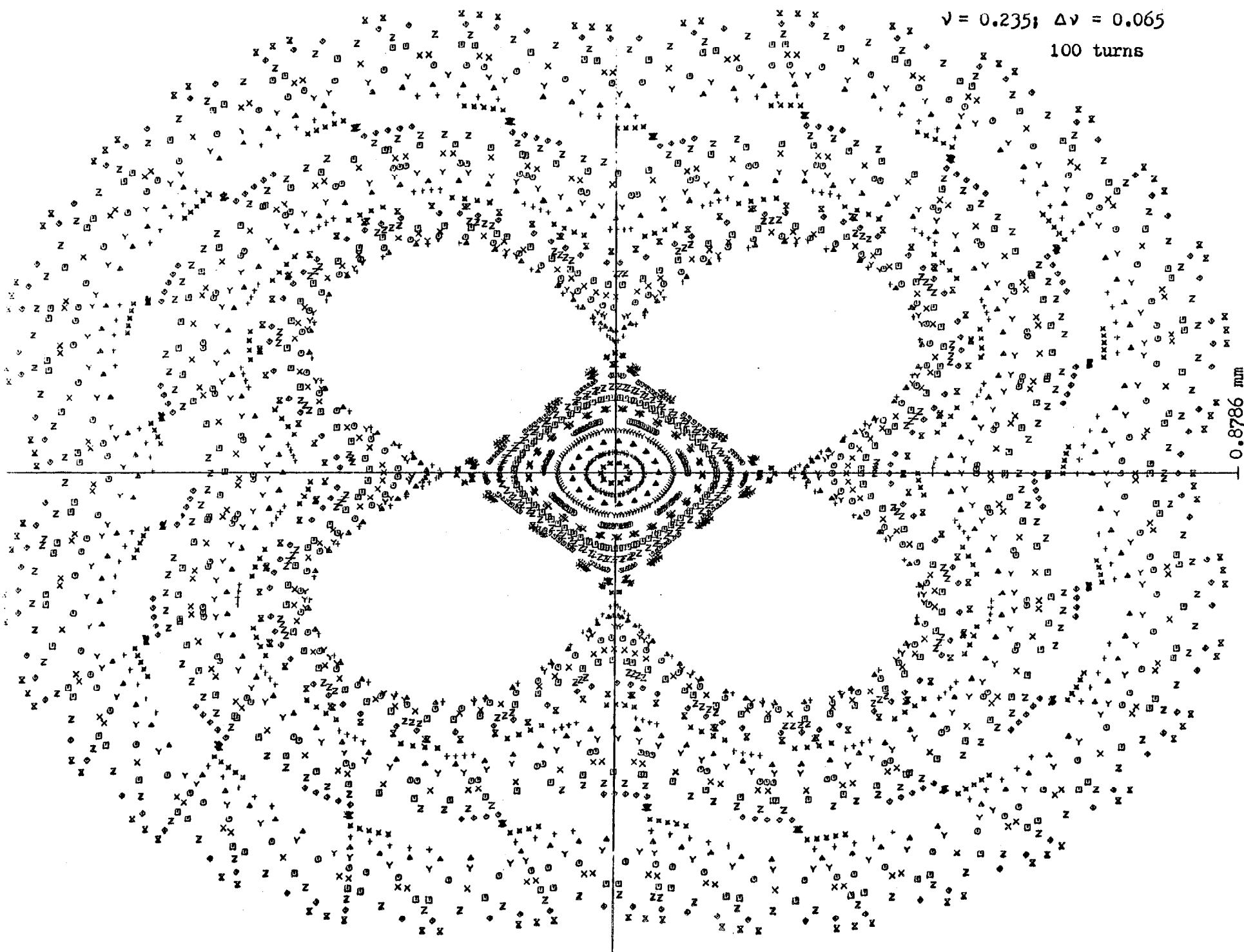
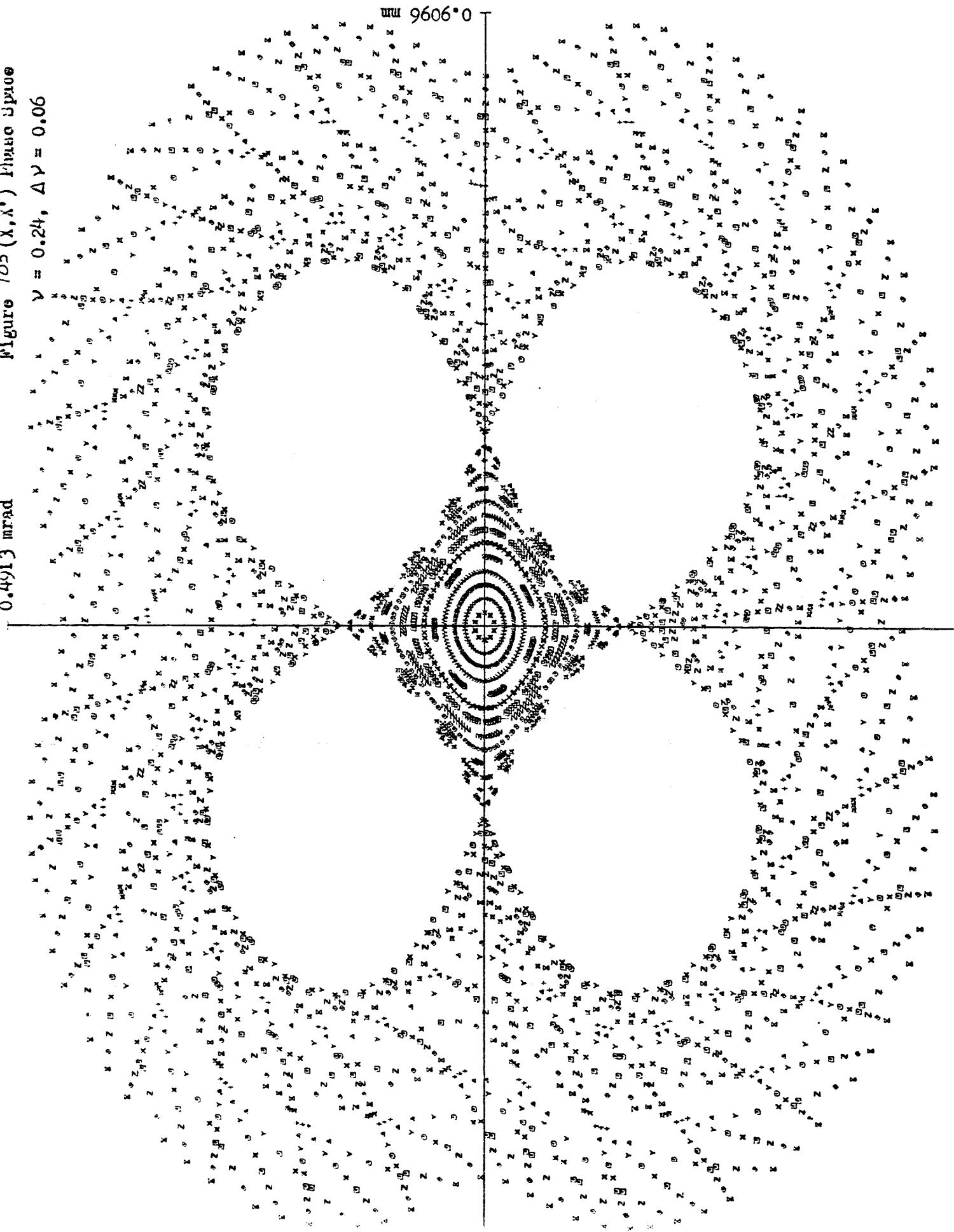
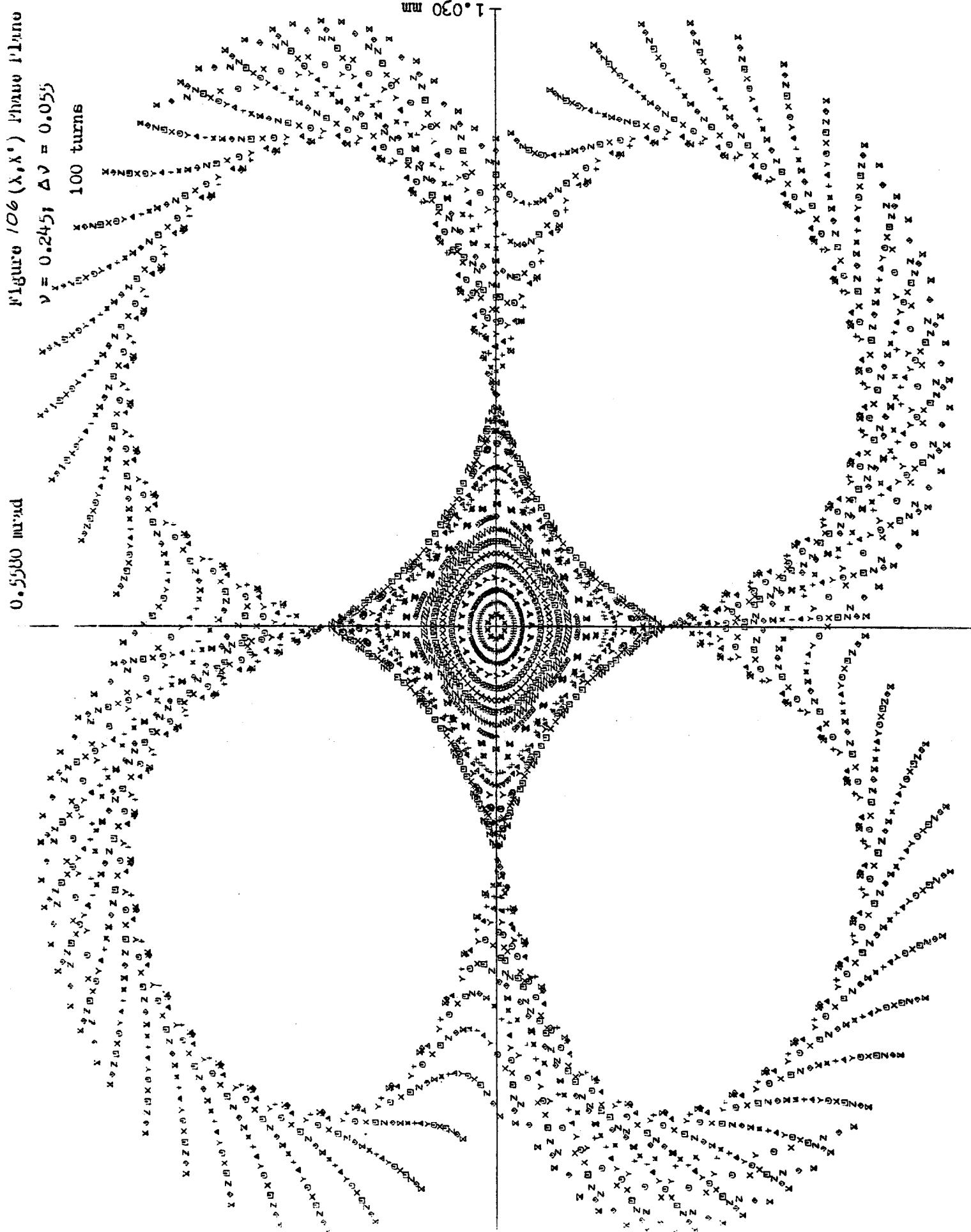


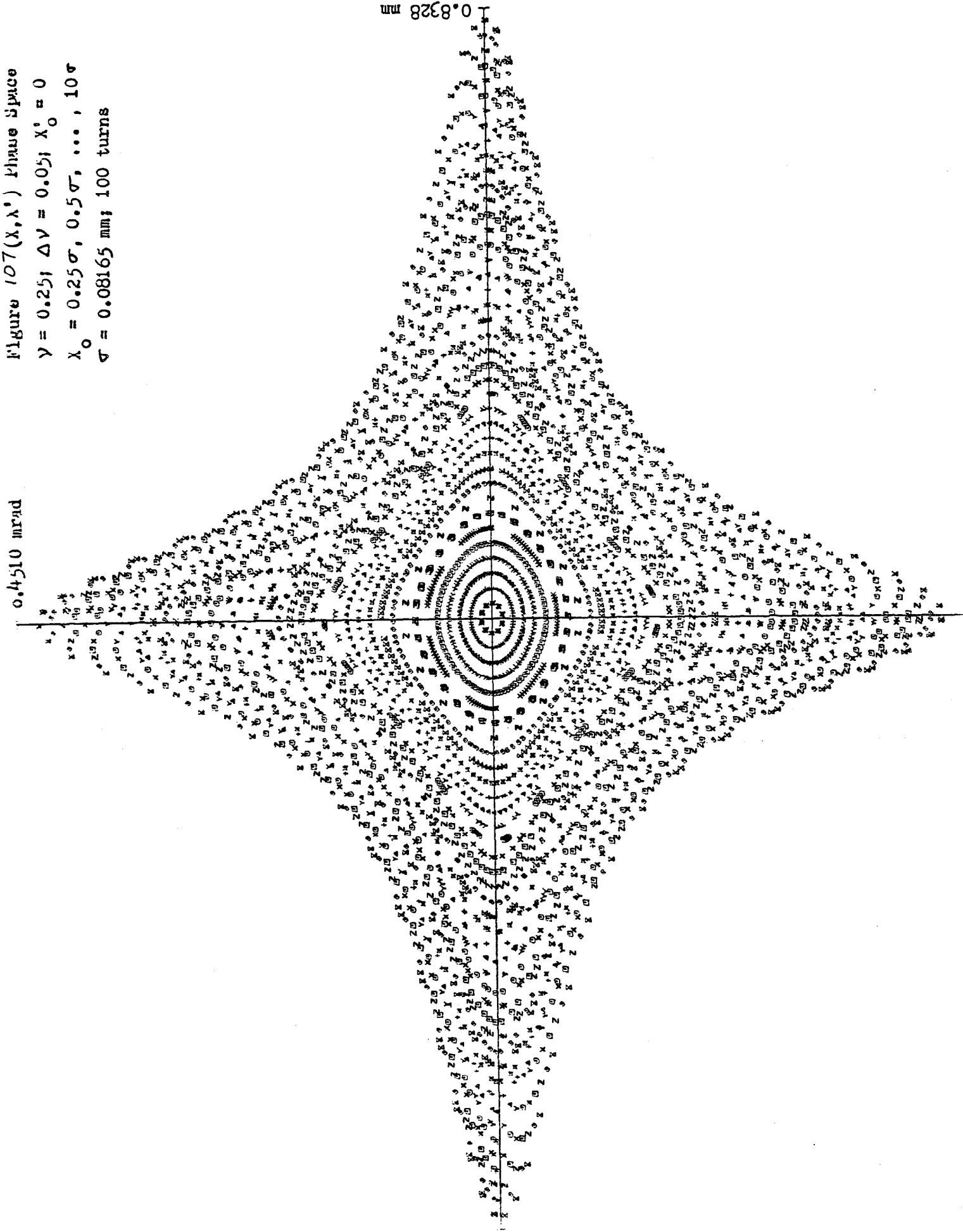
Figure 105(χ, χ') Photo Spots
 $\nu = 0.24, \Delta\nu = 0.06$





TM-1054

Figure 107(x, λ') Phase Space
 $\gamma = 0.25, \Delta v = 0.05, x_0' = 0$
 $x_0 = 0.25\sigma, 0.5\sigma, \dots, 10\sigma$
 $\sigma = 0.08165 \text{ mm}; 100 \text{ turns}$



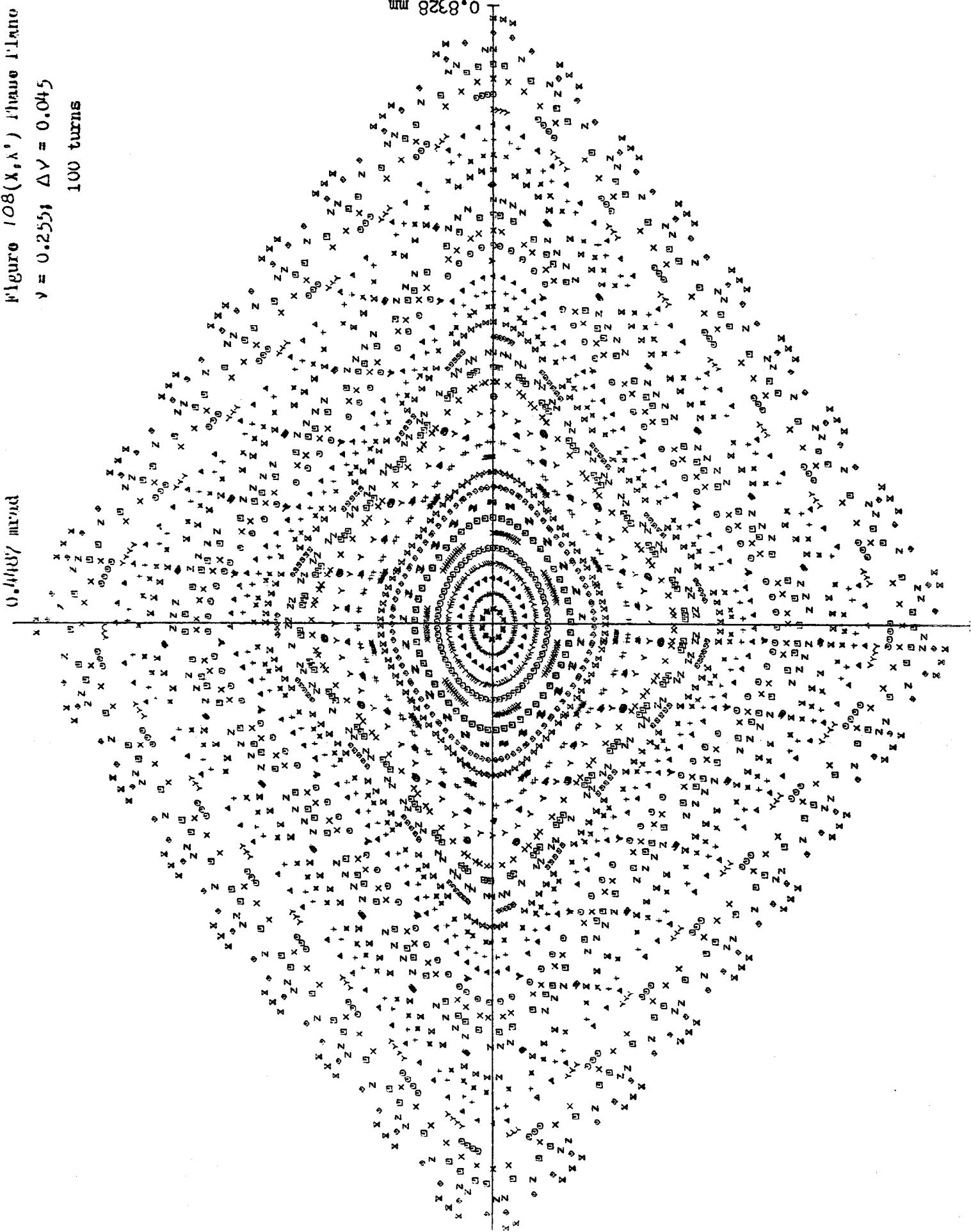


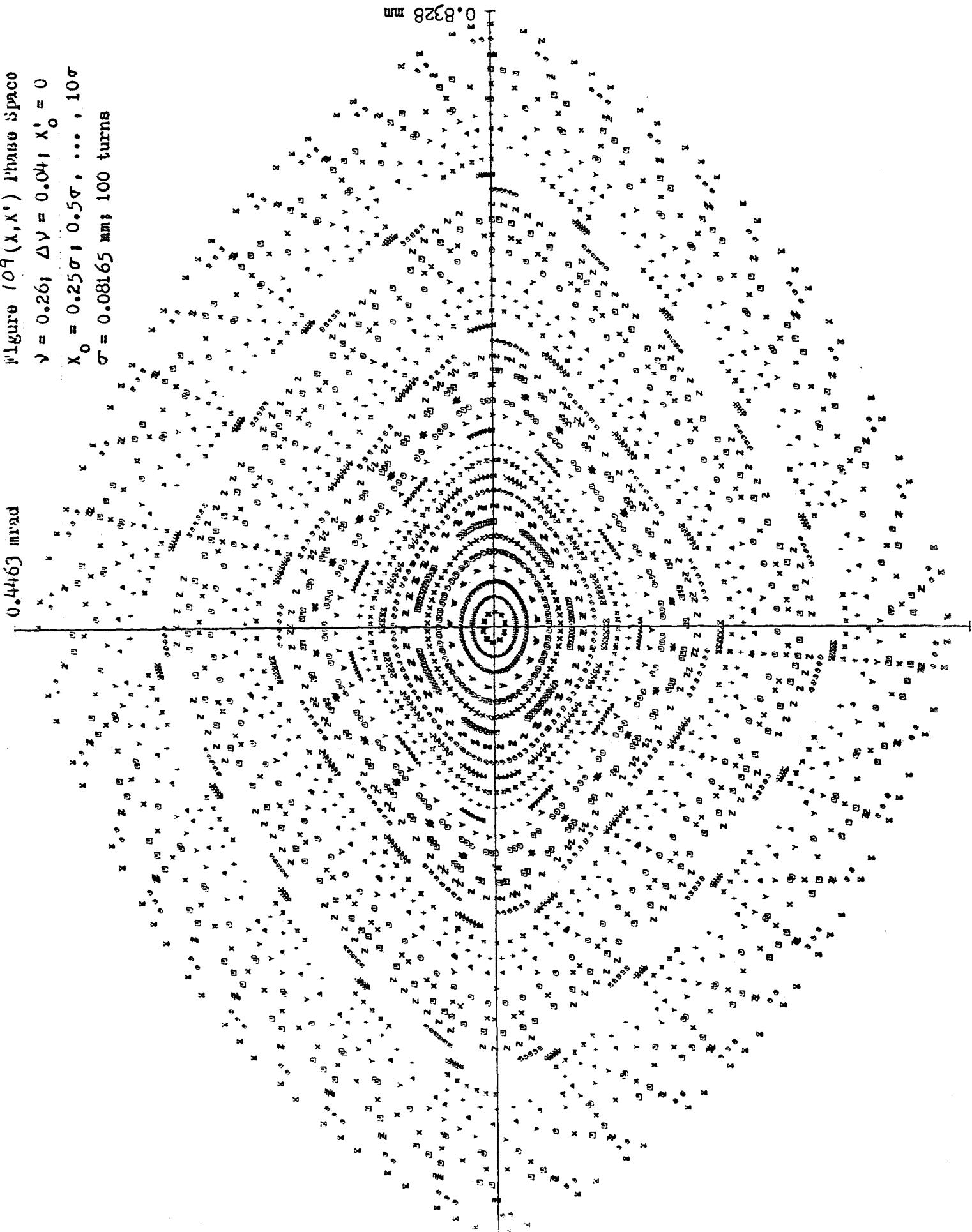
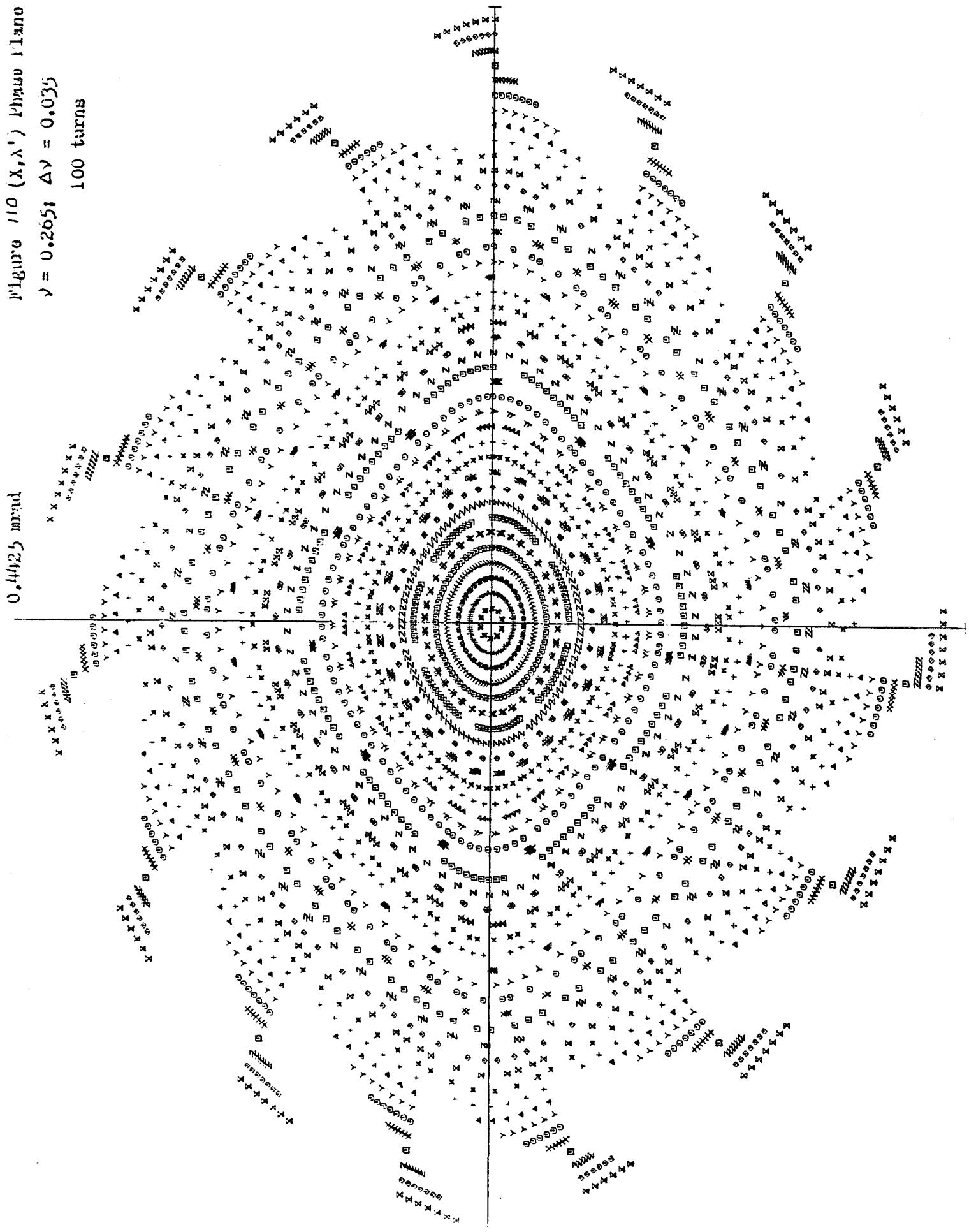
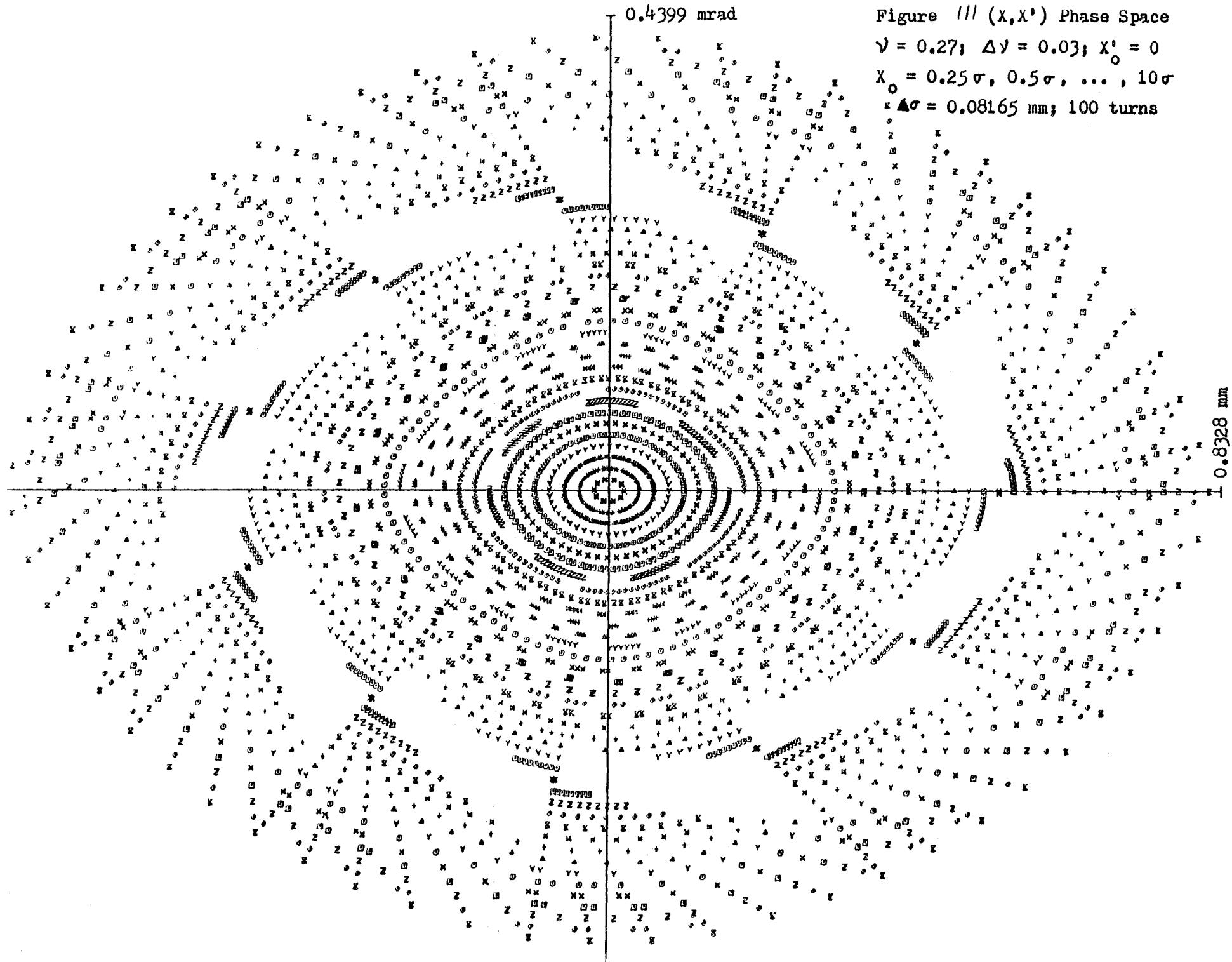
Figure 109 (X_0, X'_0) Phase Space

Figure 110
TM-1054





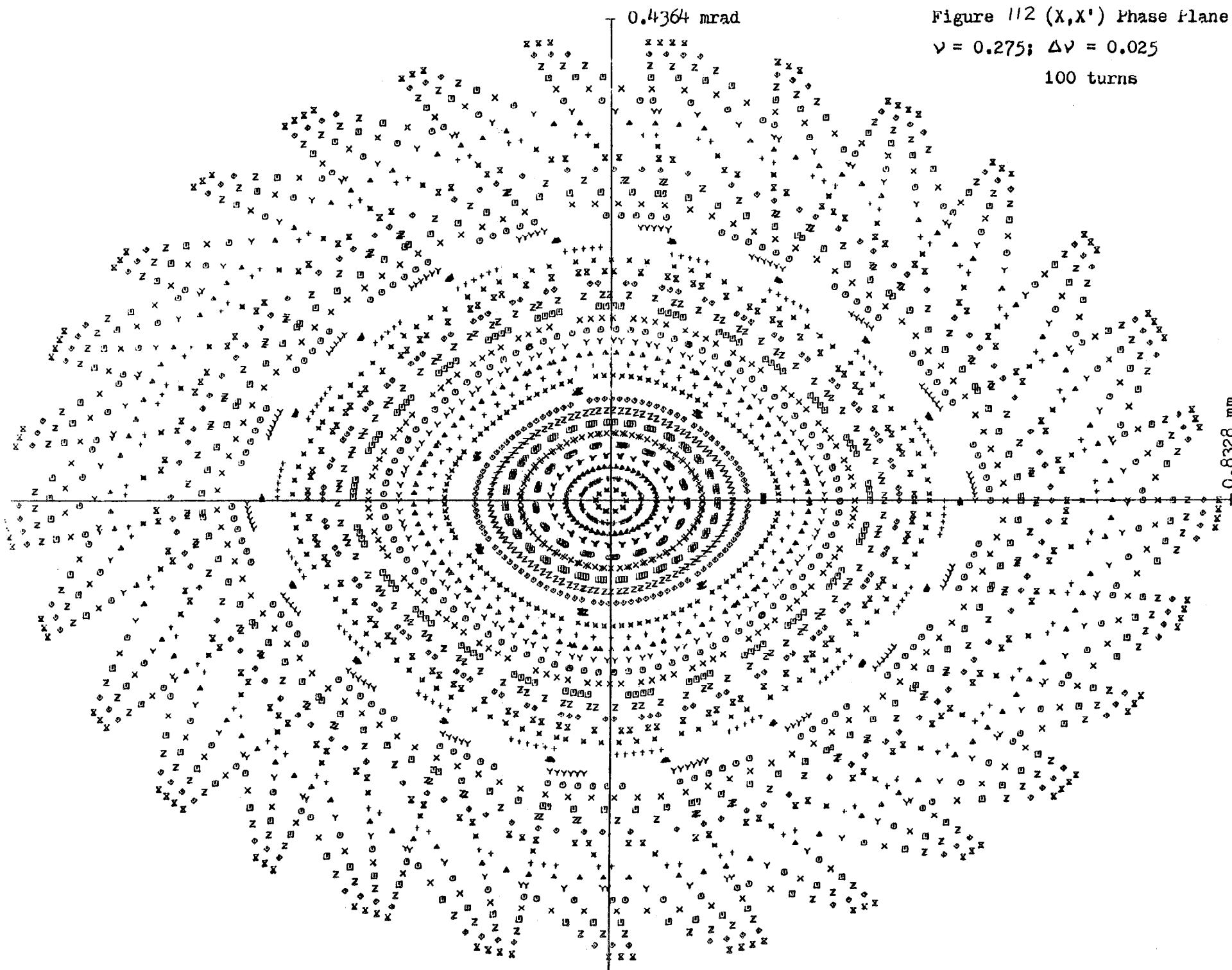


Figure 112
TM-1054

Figure 1/3 (X, X') Phase Sine $\gamma = 0.28; \Delta\gamma = 0.02; X_0' = 0$ $X_0 = 0.25\sigma, 0.5\sigma, \dots, 10\sigma$ $\sigma = 0.08165 \text{ mm}; 100 \text{ turns}$

0.8328 MM

0.01376 mm

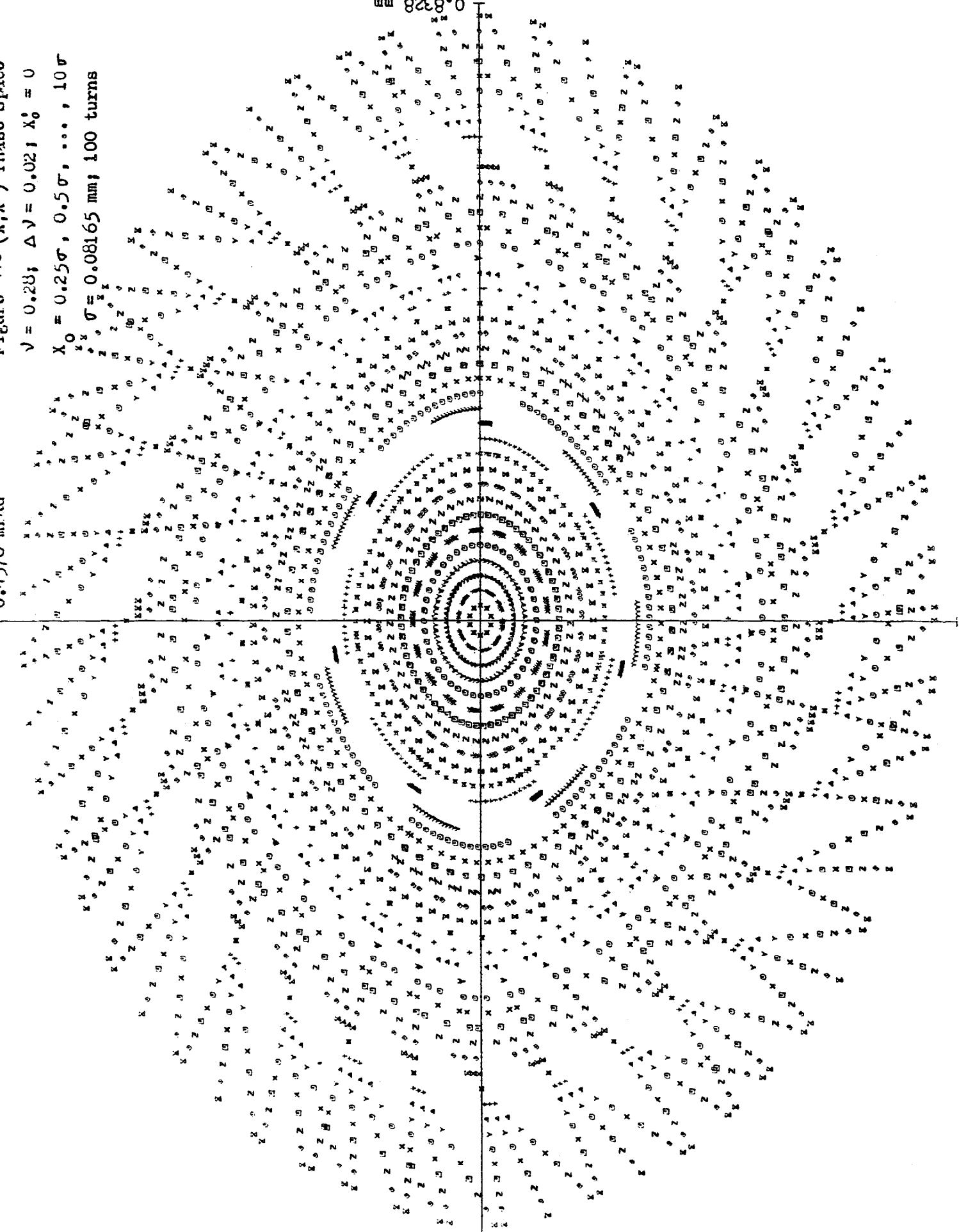


Figure 114 (x, x') Phase Plane
 $\nu = 0.285, \Delta\nu = 0.015$
100 turns

$\pi = 0.4262$ mrad

0.8328 mm

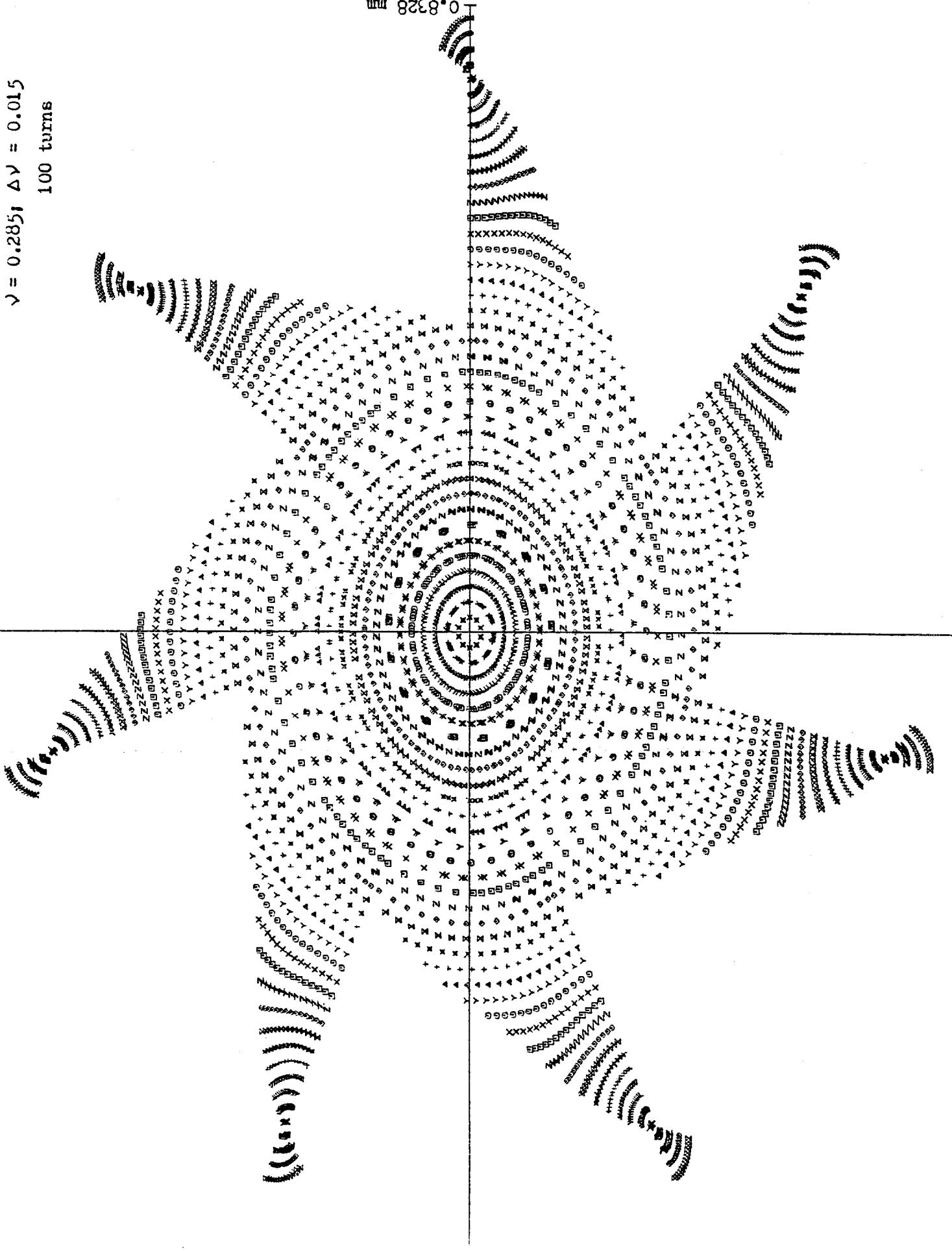


Figure 115

TM-1054

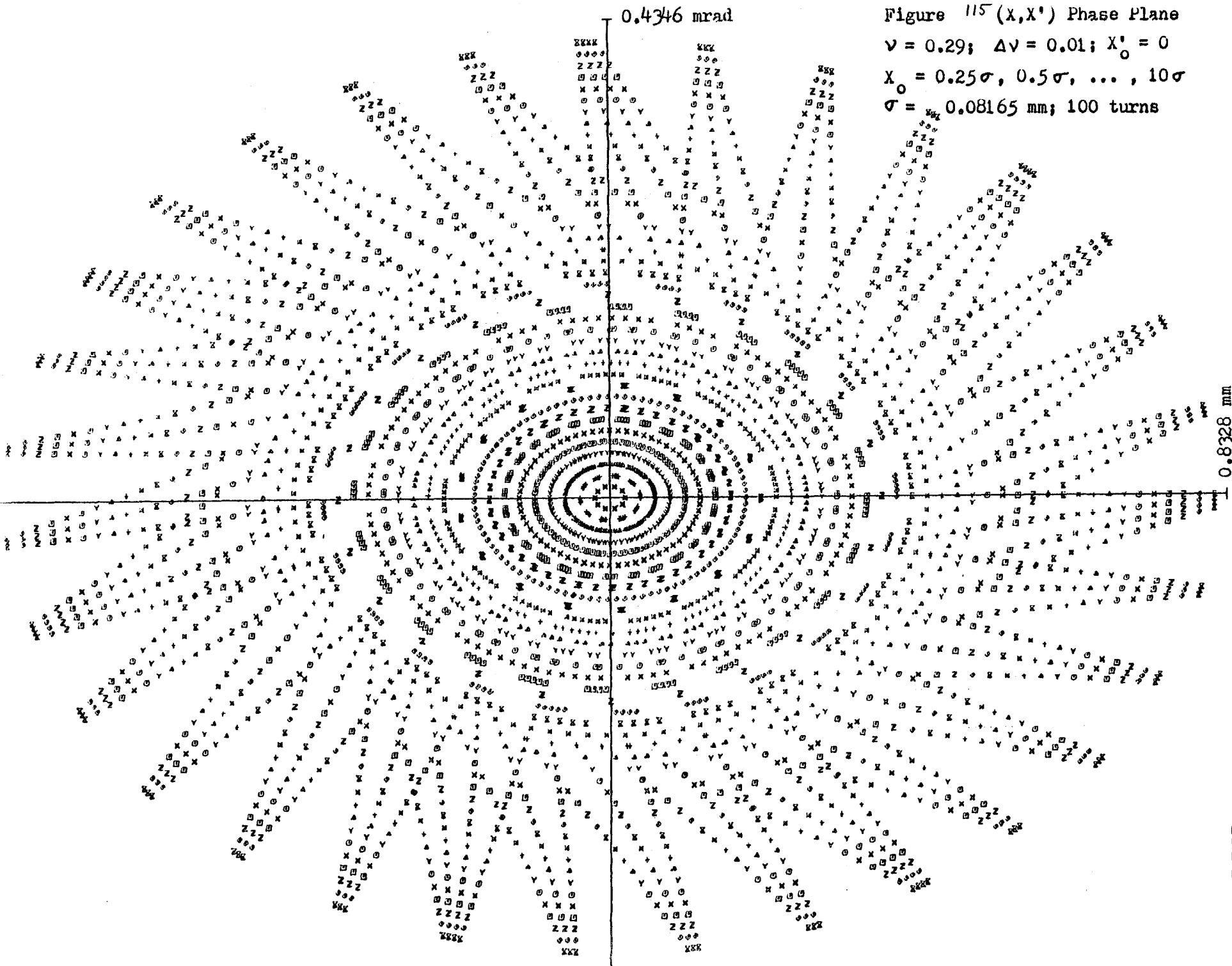
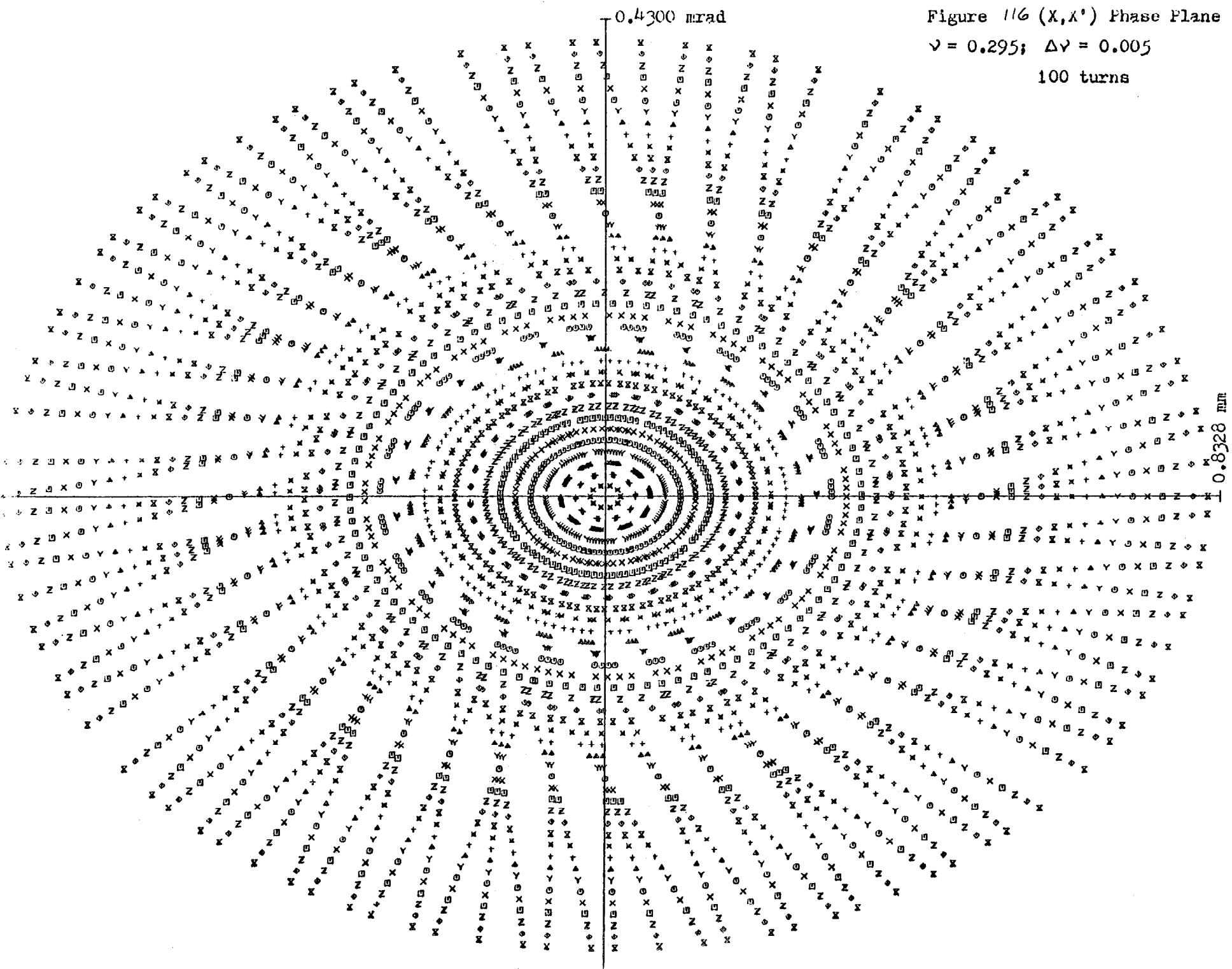
Figure 115 (x, x') Phase Plane $v = 0.29; \Delta v = 0.01; x_0' = 0$ $x_0 = 0.25\sigma, 0.5\sigma, \dots, 10\sigma$ $\sigma = 0.08165 \text{ mm}; 100 \text{ turns}$

Figure 116



0.8326mm

Figure 117 (X, X') Phase Plane

 $\gamma = 0.30$ $\Delta \nu = 0.00$

100 turns

 $X_0 = 0.25\sigma, 0.5\sigma, \dots, 10\sigma$ $\sigma = 0.08165\text{mm}; X'_0 = 0$

0.400' / mm

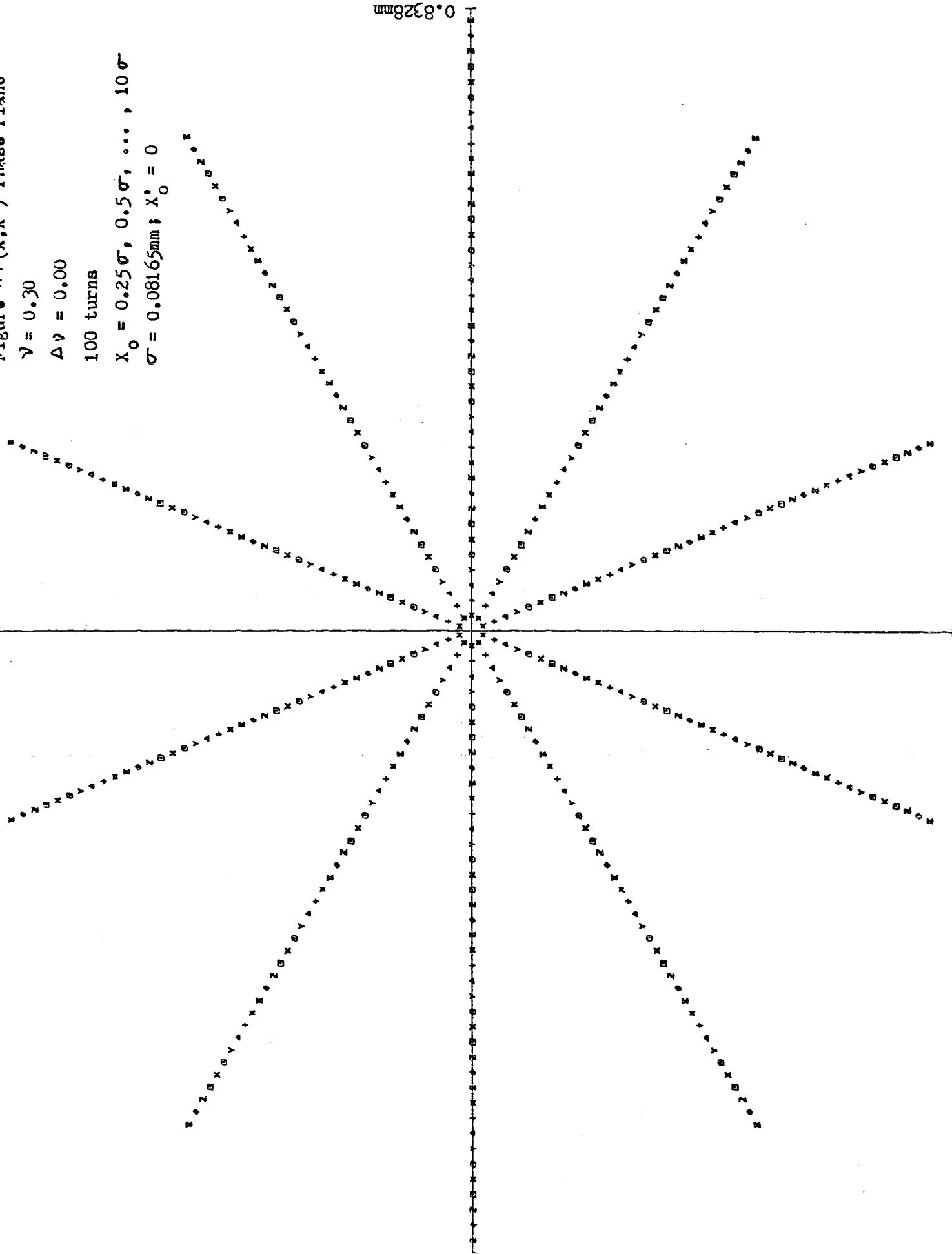


Figure 118
TM-1054

Figure 118 (X, X') Phase plane

$\gamma = 0.25; \Delta\nu = 0.10$

100 turns

0.5482 mrad



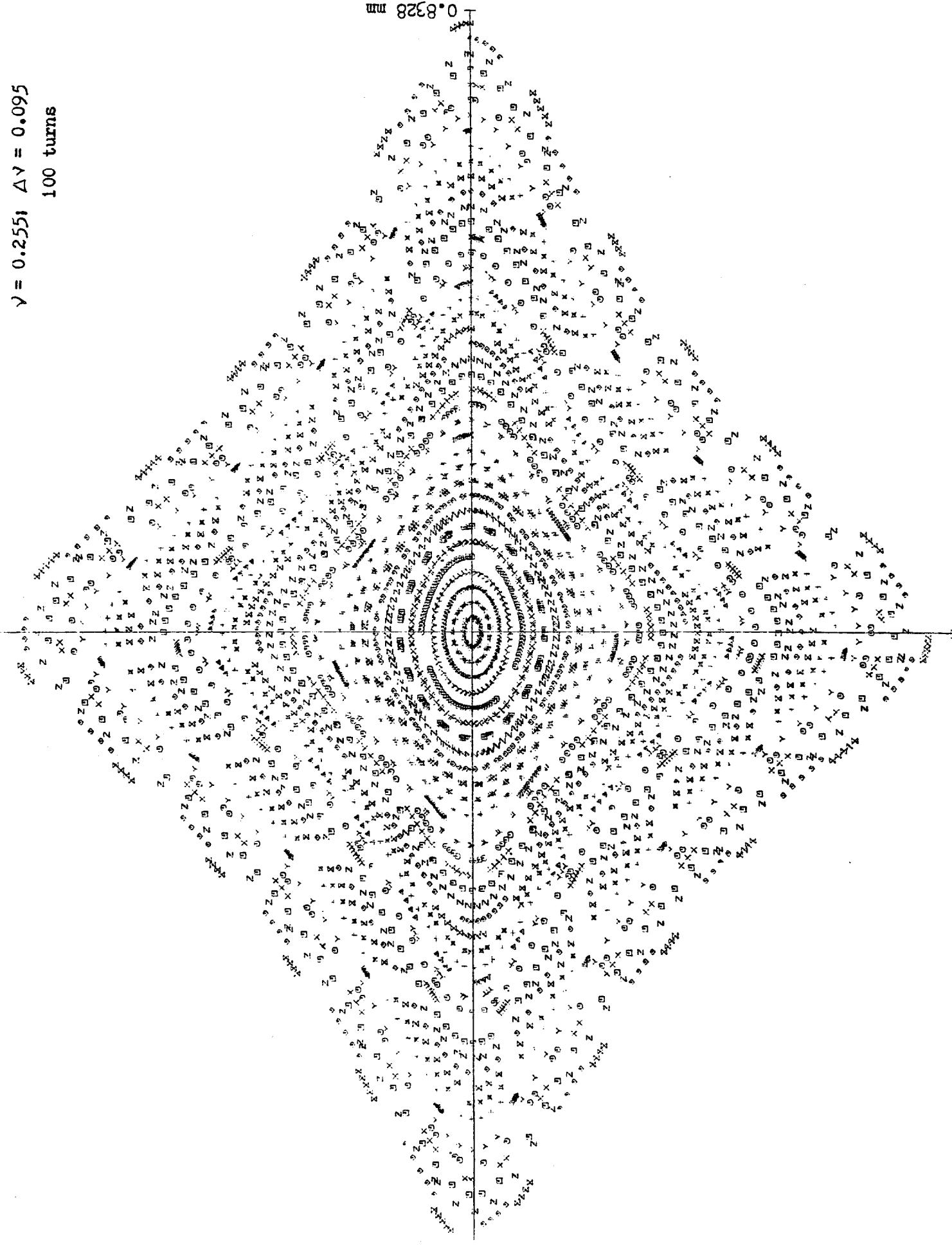
Figure 119 (X, X') Phase Plane 0.5430 mrad 
 $\gamma = 0.2551 \Delta\gamma = 0.095$
 100 turns

Figure 120
TM-1054

Figure 120(X, X') Phase Plane

0.5347 mrad

$\gamma = 0.26; \Delta\gamma = 0.09$

100 turns

0.8328 MM

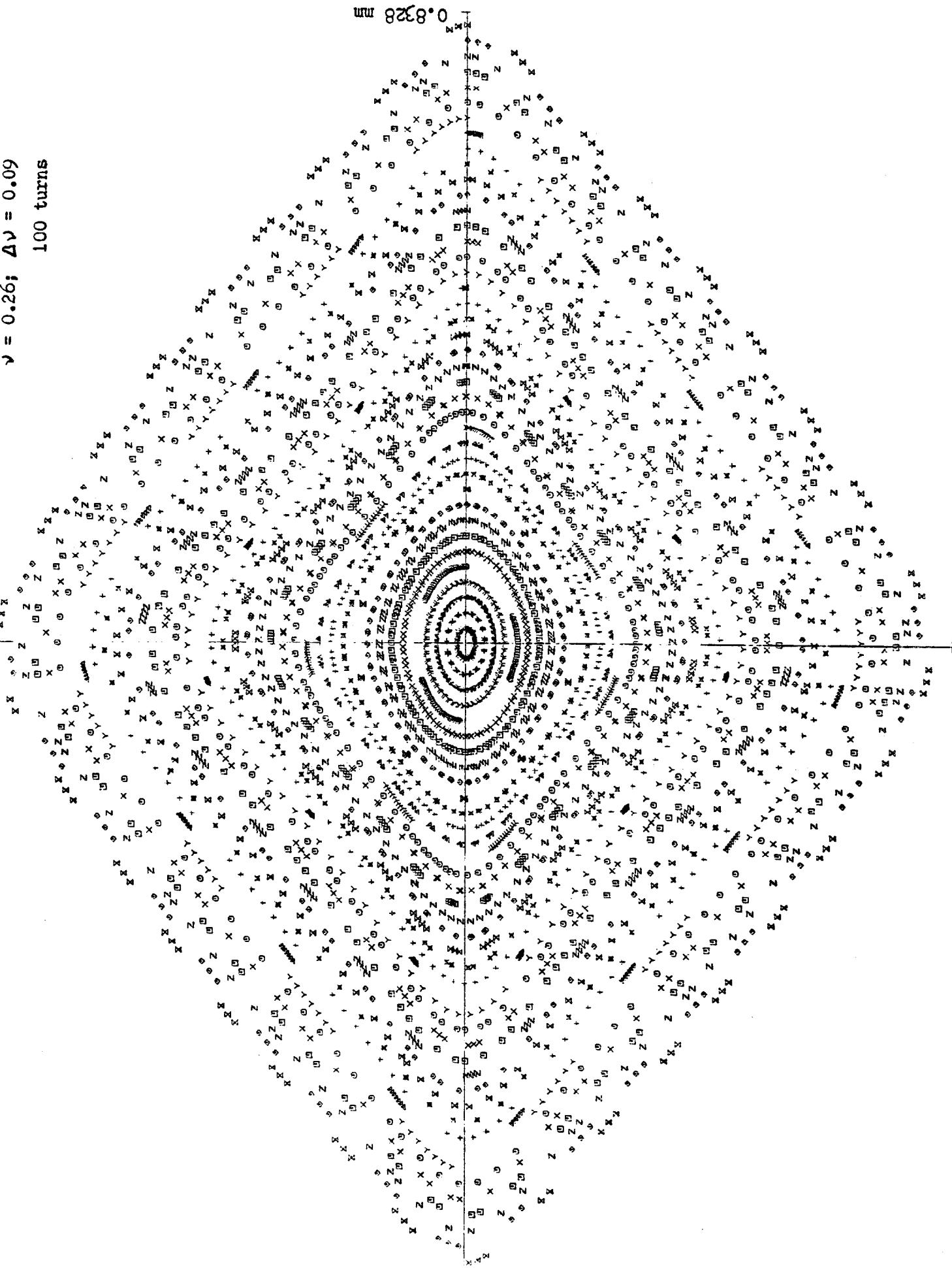


Figure 121
TM-1054

Figure 121 (χ, λ') Phase plane
 $\nu = 0.265$; $\Delta\nu = 0.0085$
 100 turns

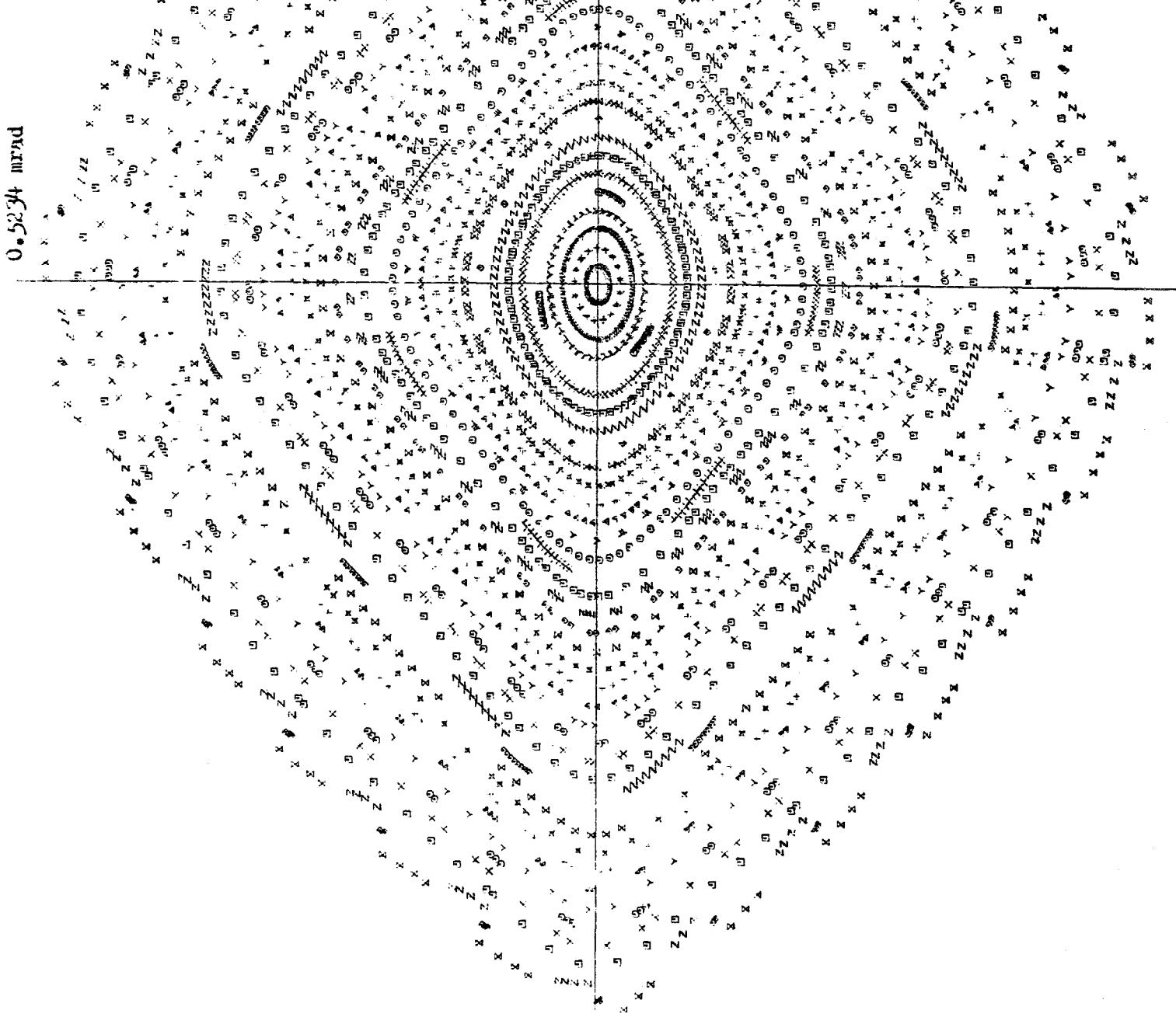


Figure 122
TM-1054

Figure 122(λ, λ') Phase Plane

$y = 0.27; \Delta \nu = 0.08$

100 turns

0.5293 mrad

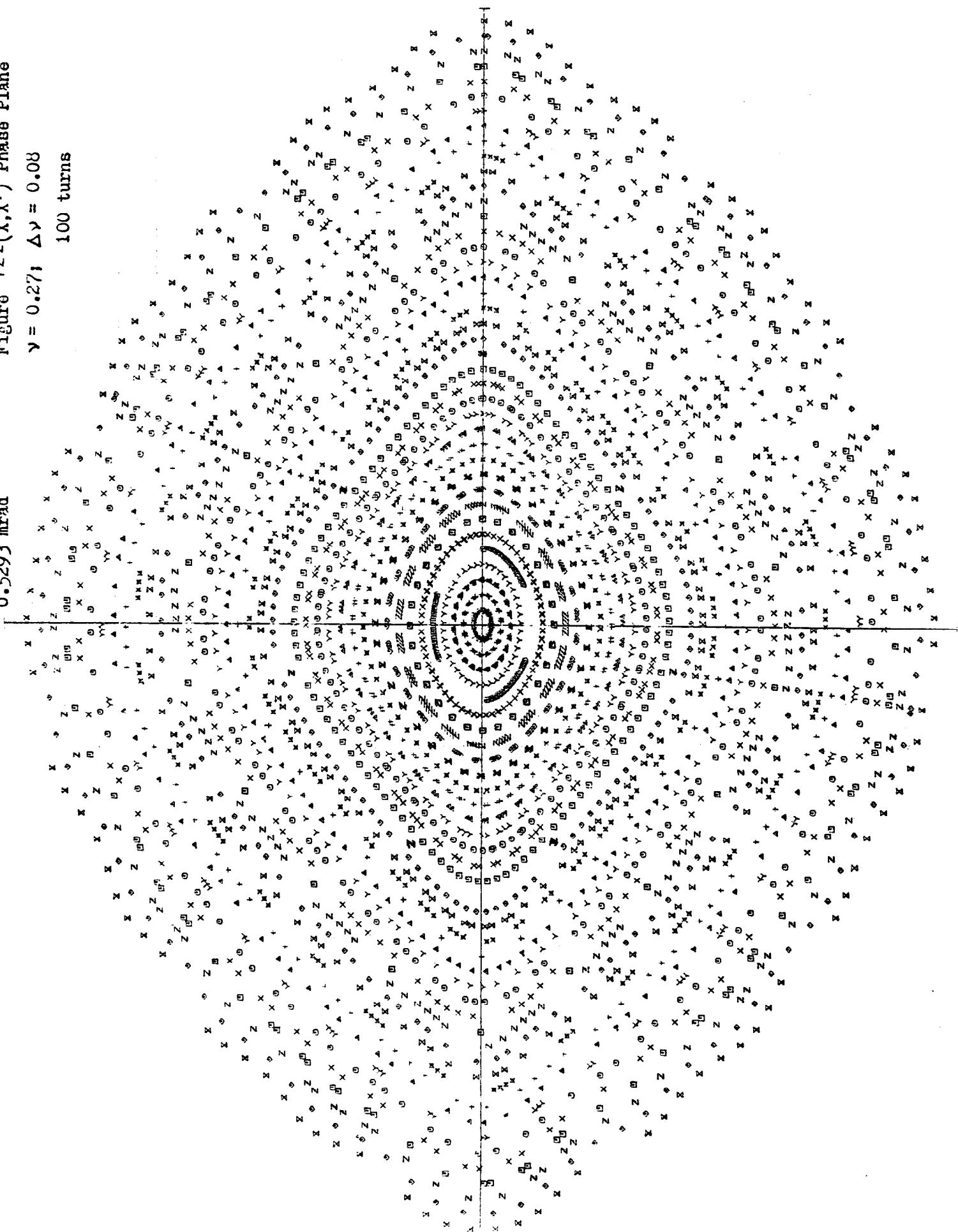


Figure 123 (X, X') Phase Plane
 $\gamma = 0.275; \Delta\gamma = 0.075$
 100 turns

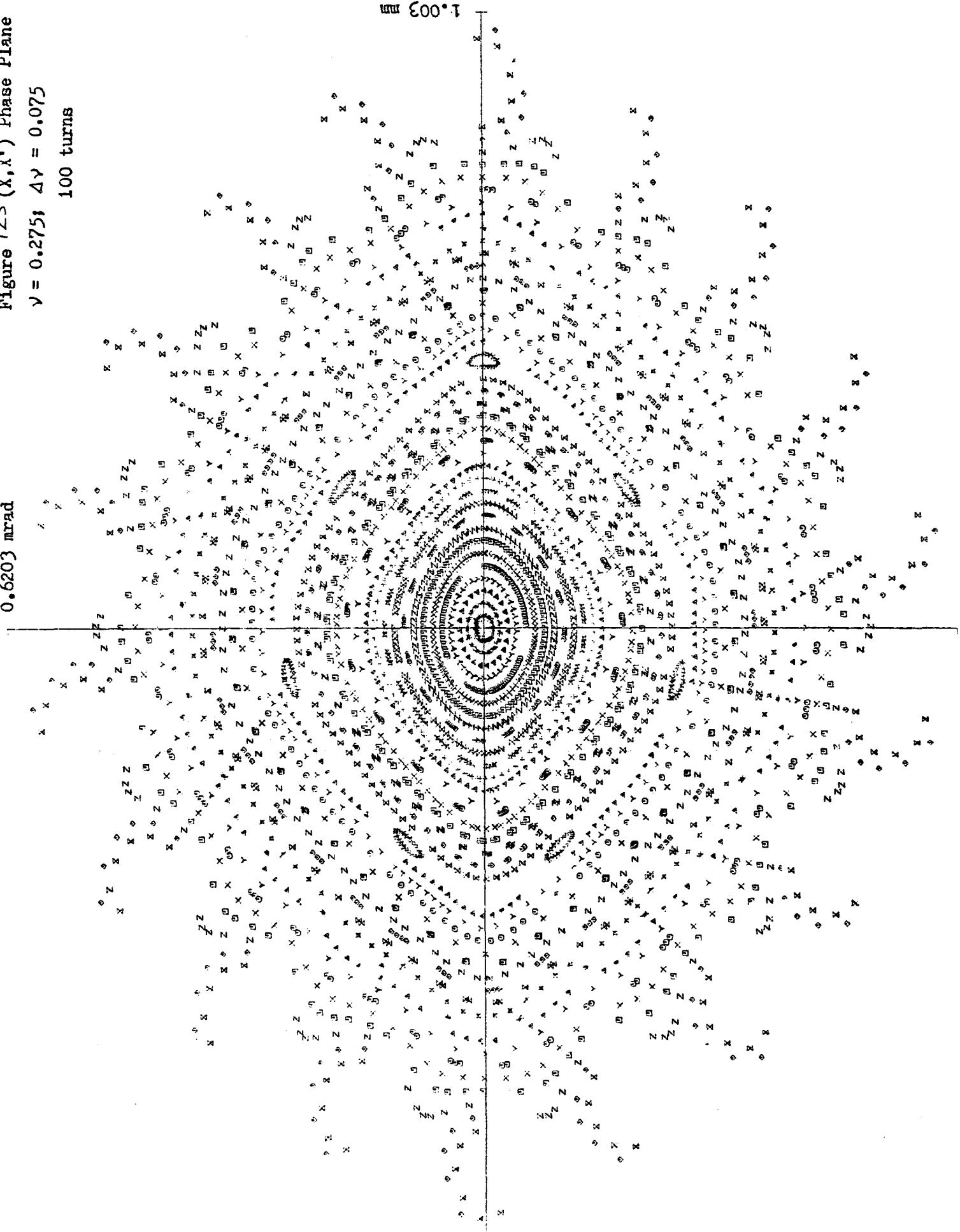


Figure 124
TM-1054

Figure 124 (λ, λ') Phase Plane

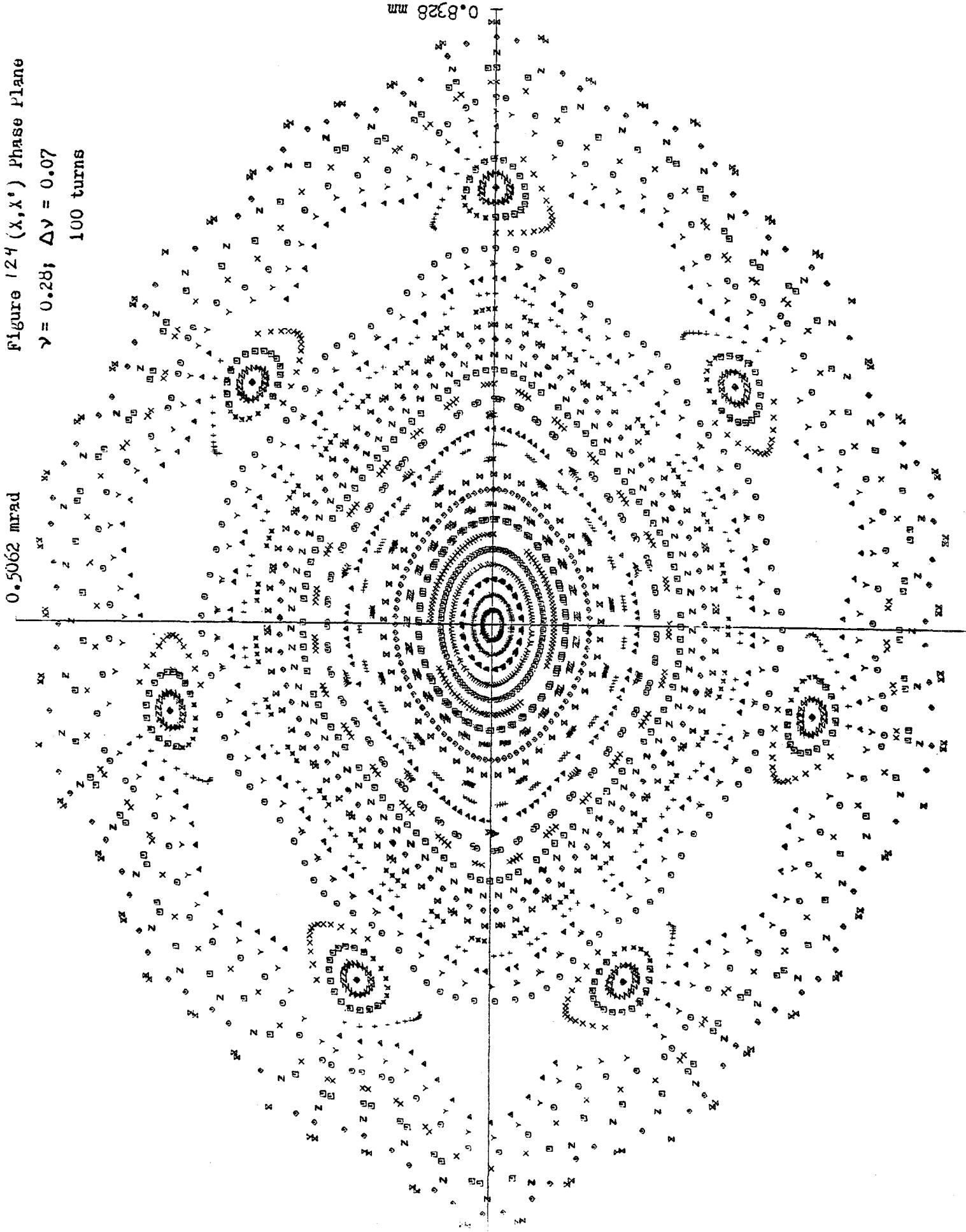
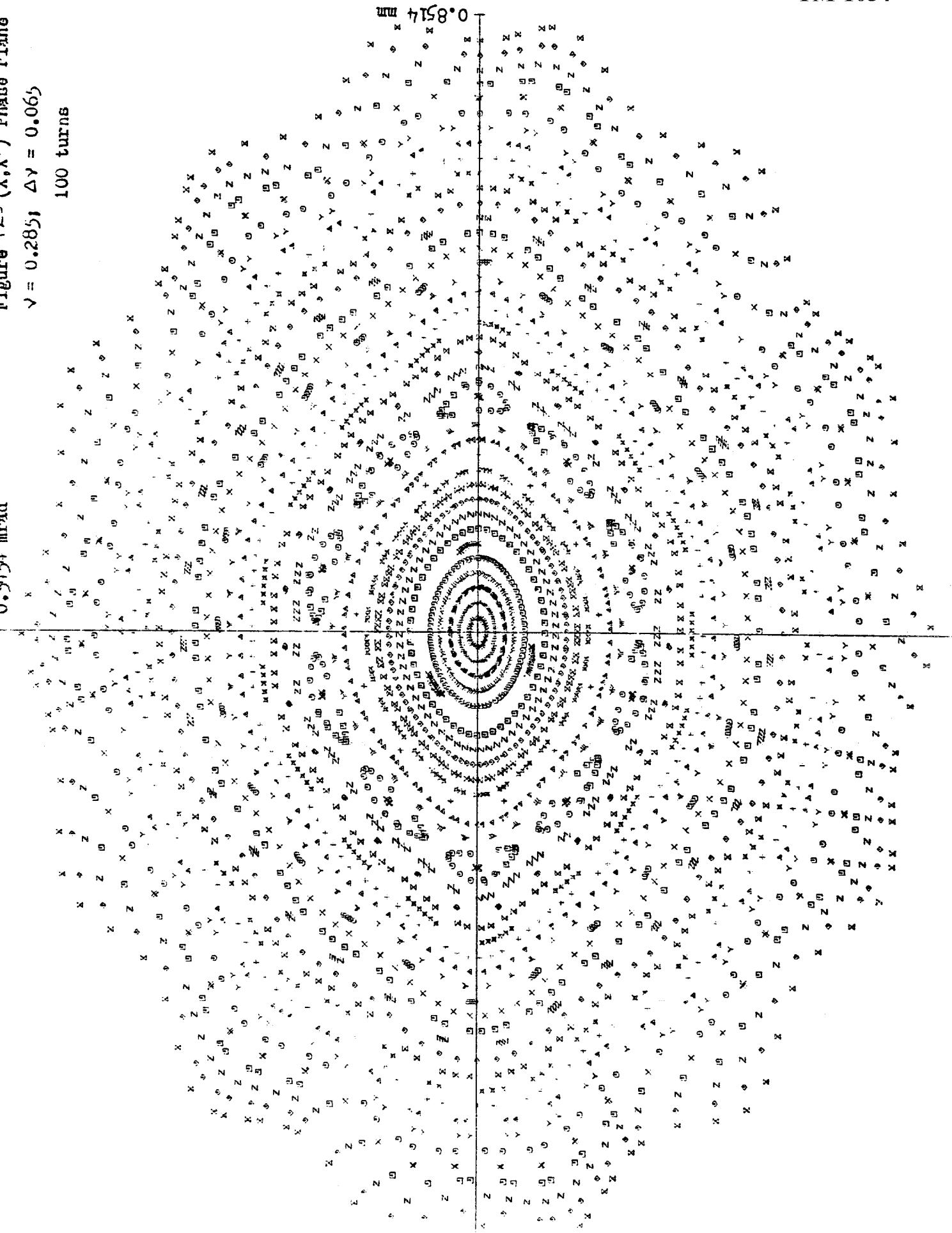


Figure 125 (λ, λ') Phase Line $\gamma = 0.285, \Delta\gamma = 0.065$

100 turns

0.514 mrad



TM-1054

Figure 126(x, x') Phase plane $\gamma = 0.29; \Delta\gamma = 0.06$

100 turns

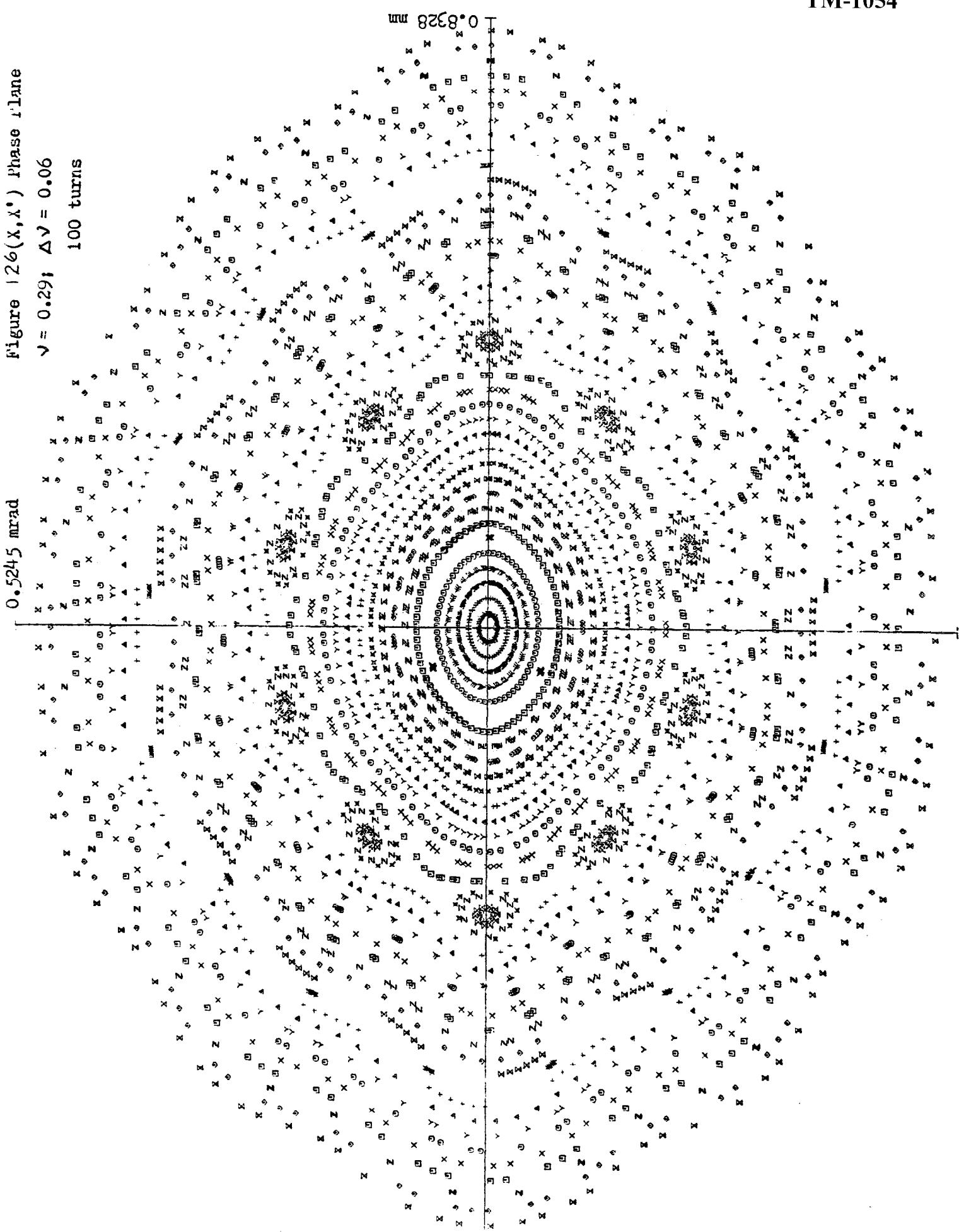


Figure 127 (x, x') Phase Plane $\nu = 0.295; \Delta\nu = 0.055$

100 turns

0.4878 mrad

0.8328 mm

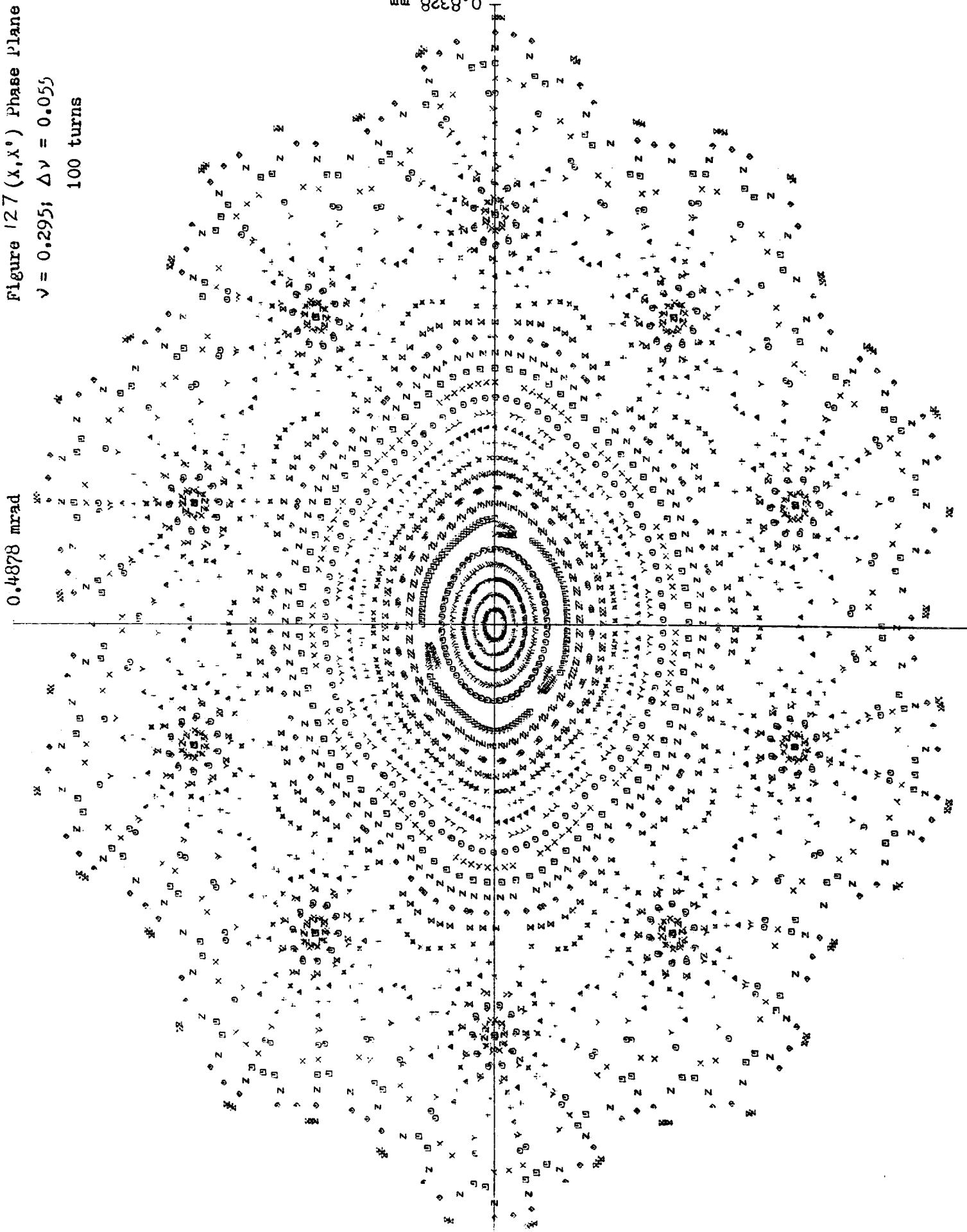


Figure 128
TM-1054

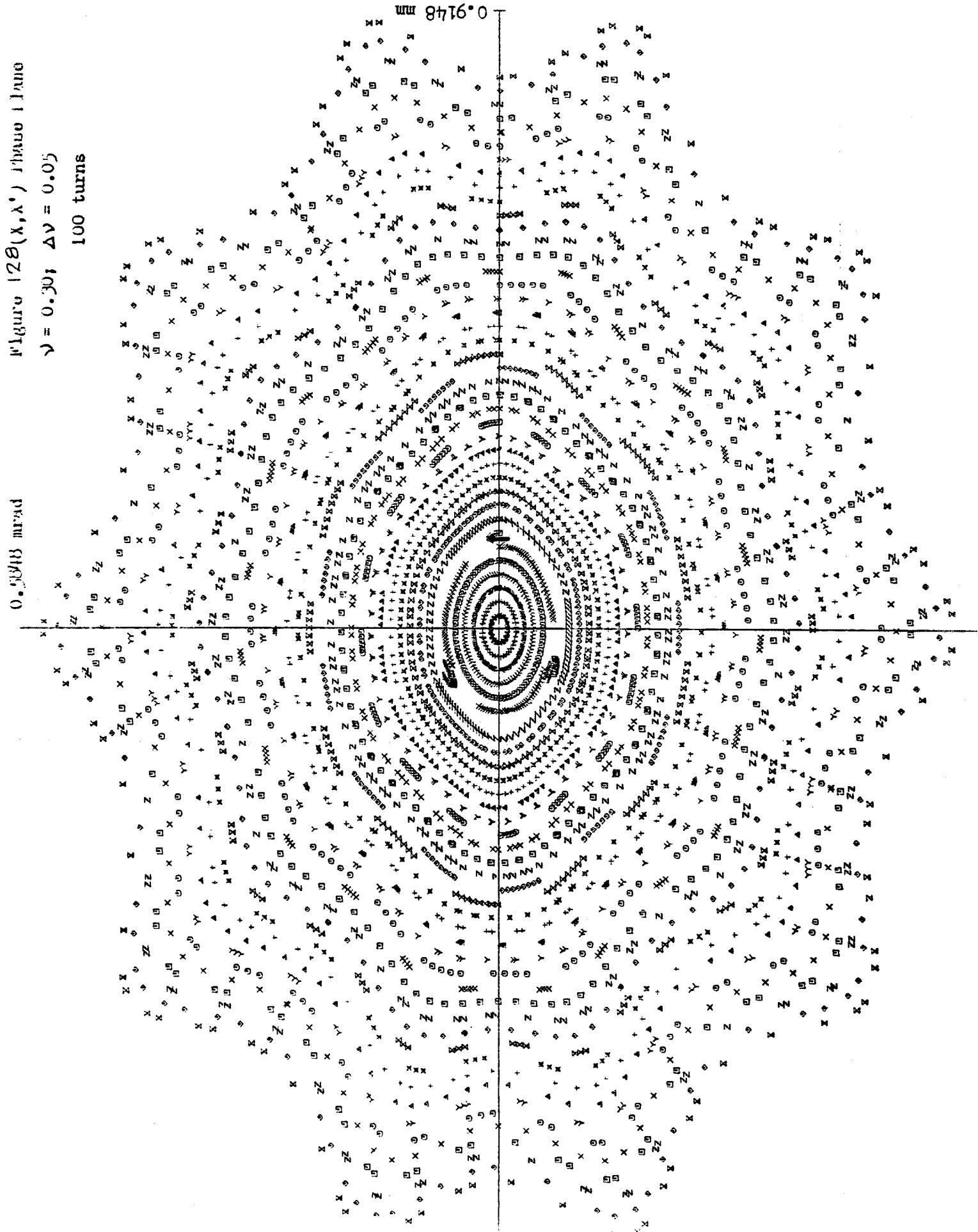
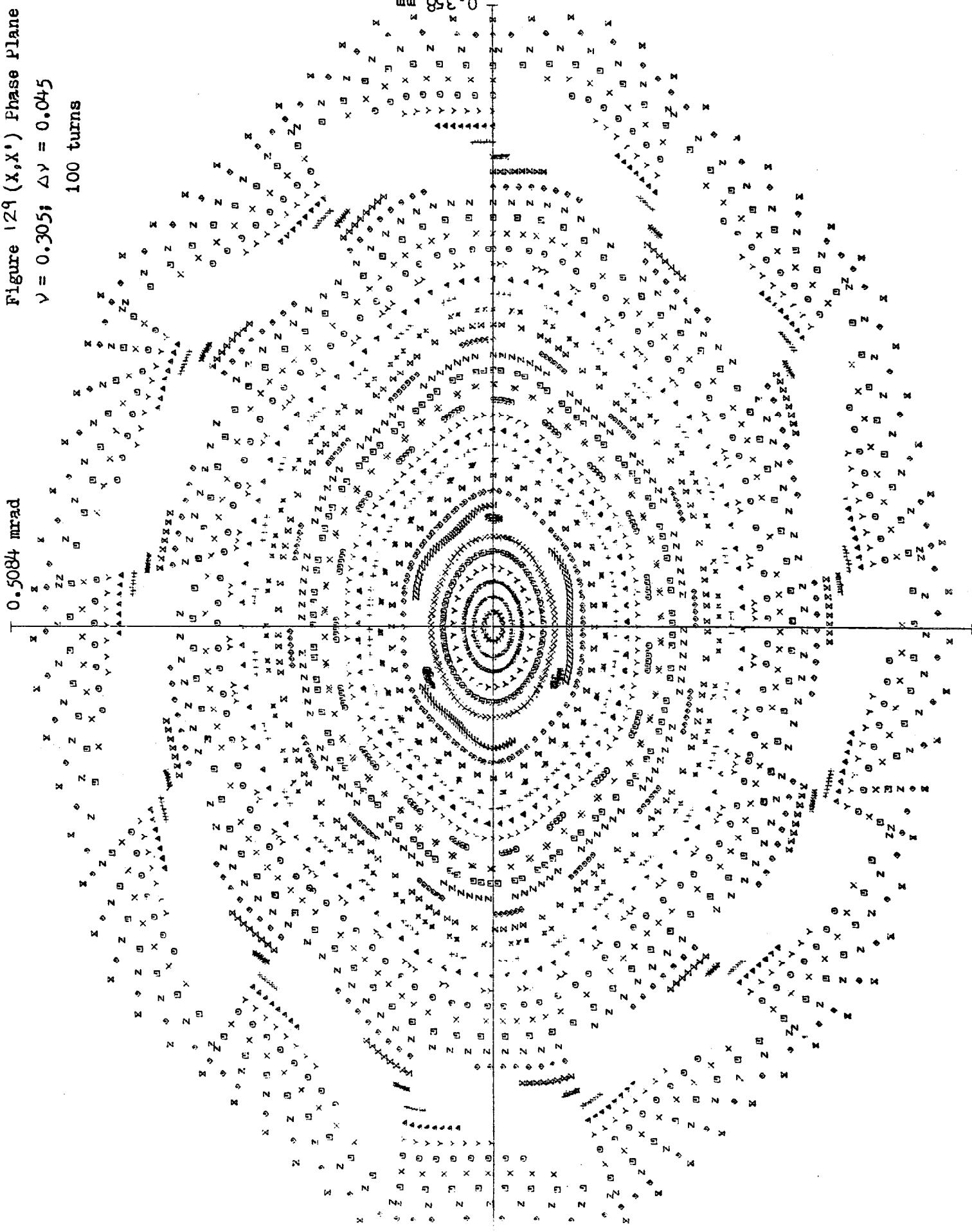


Figure 129
TM-1054



TM-1054

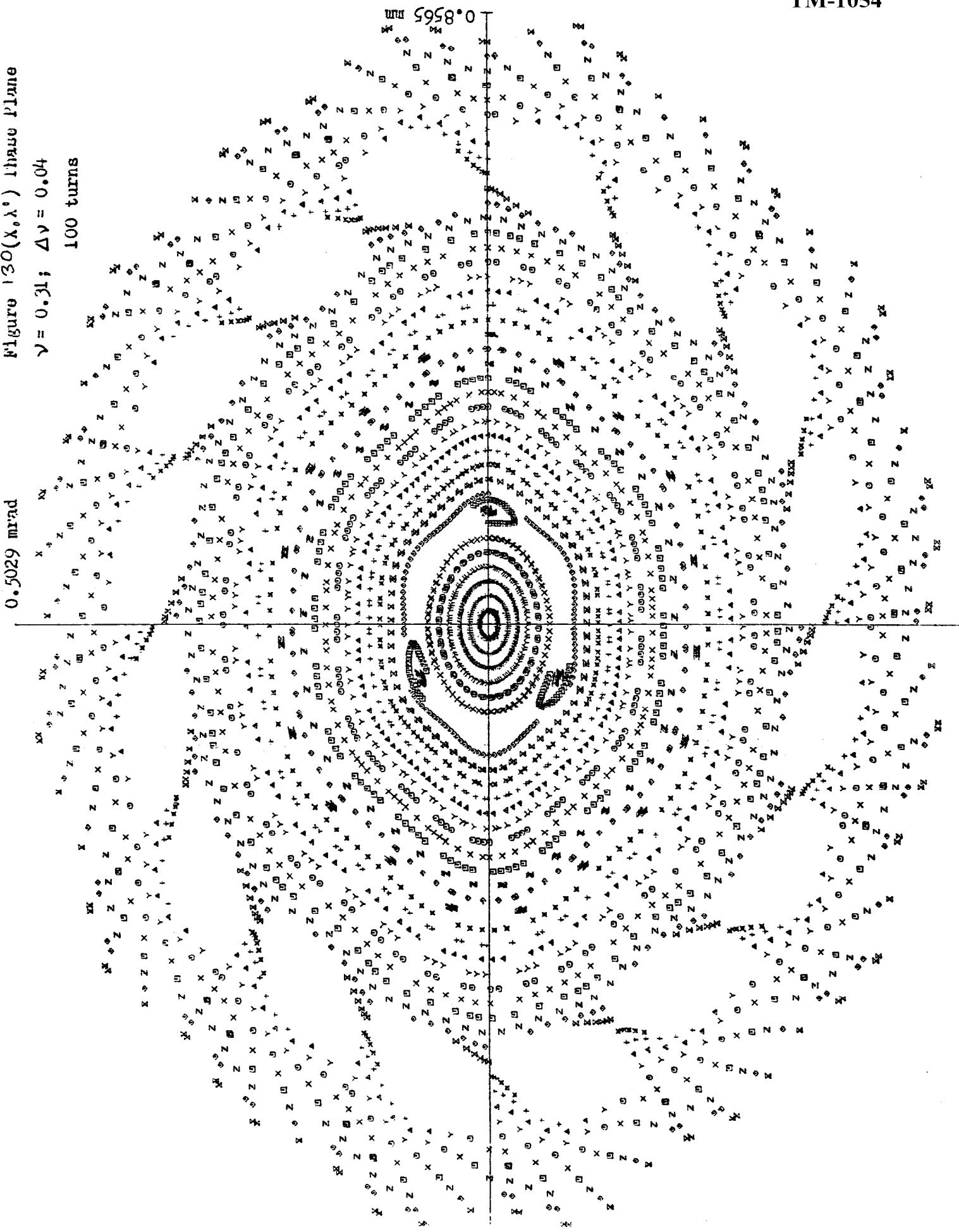
Figure 130($\lambda_0\lambda^*$) Phase Plane
 $v = 0.31; \Delta v = 0.04$
 100 turns


Figure 131
TM-1054

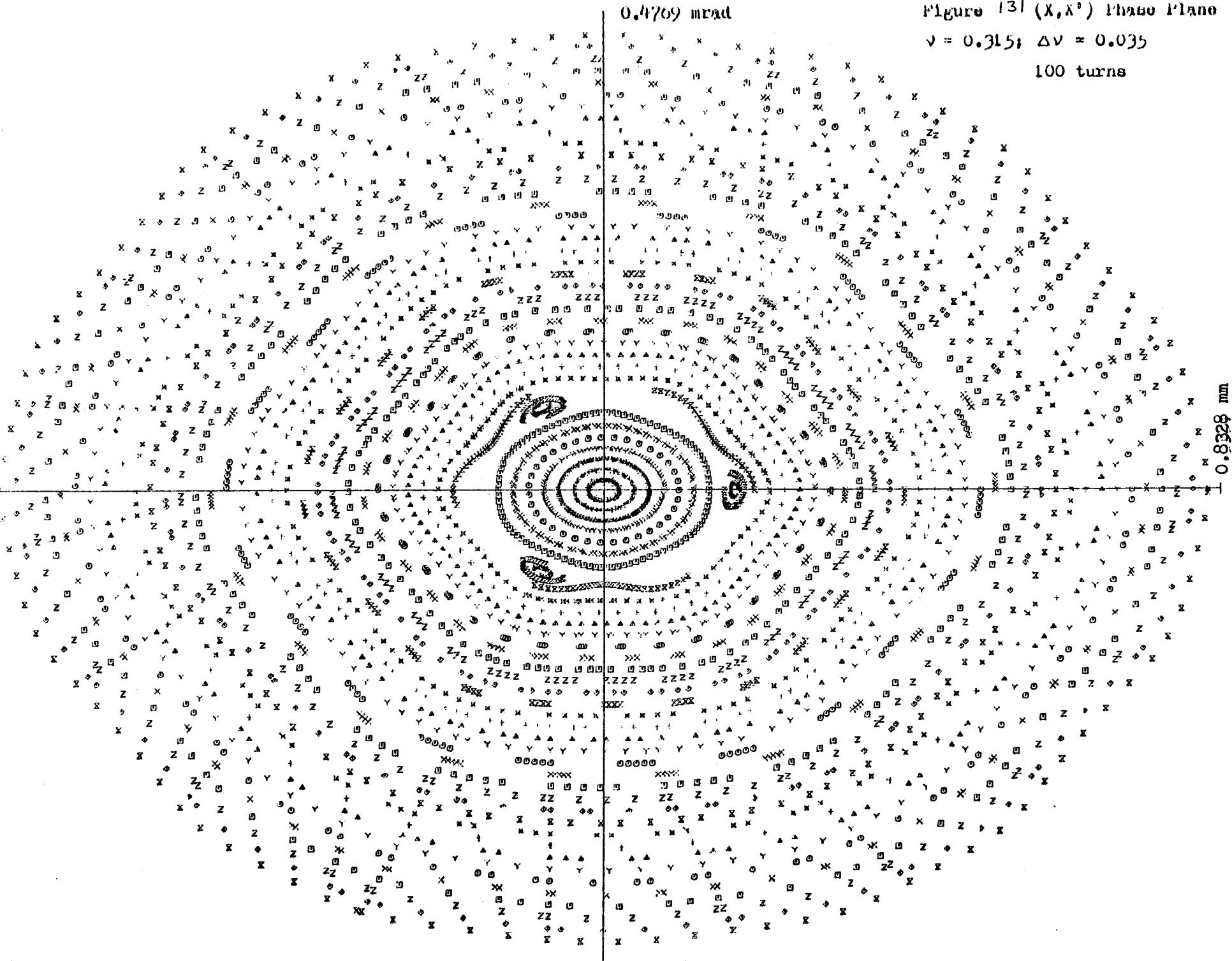


Figure 131 (x, x') Phase Plane
 $v = 0.315$; $\Delta v = 0.035$
100 turns

Figure 132

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Figure 132 (λ, λ') Phase Plane

$v = 0.32; \Delta v = 0.03$

100 turns

0.4665 mrad

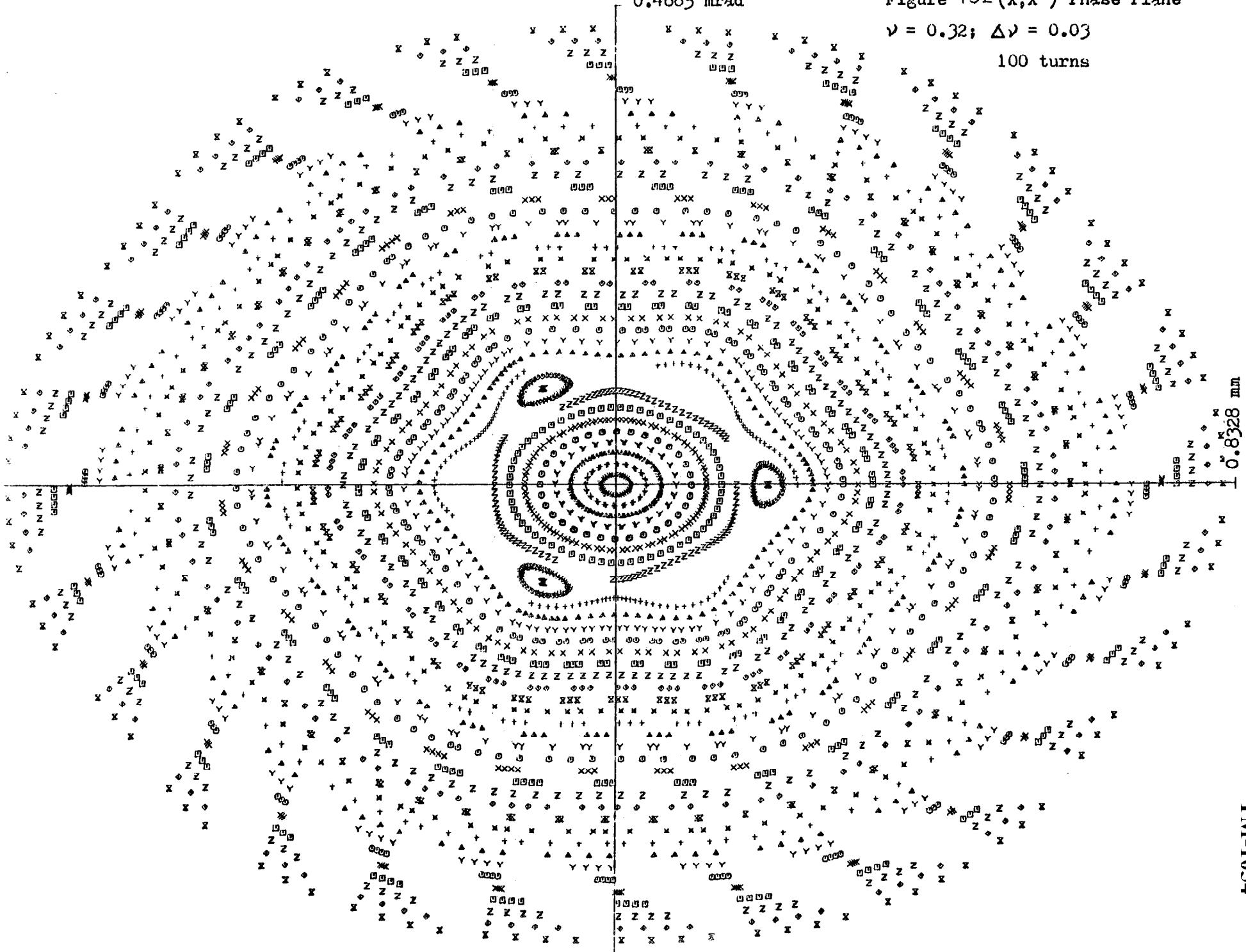
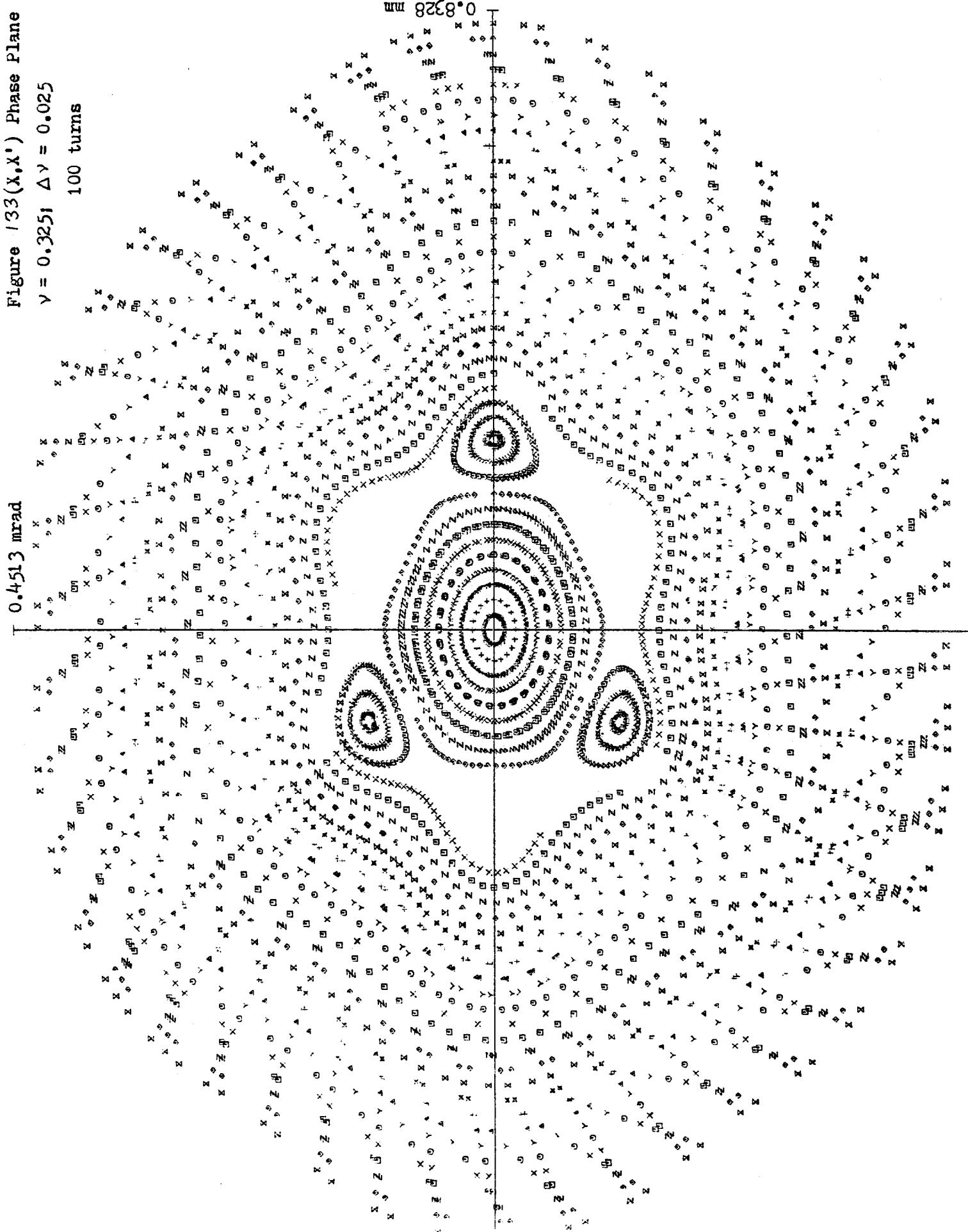


Figure 133(X,X') Phase Plane

$\nu = 0.3251$ $\Delta\nu = 0.025$

100 turns

T 0.4513 mrad



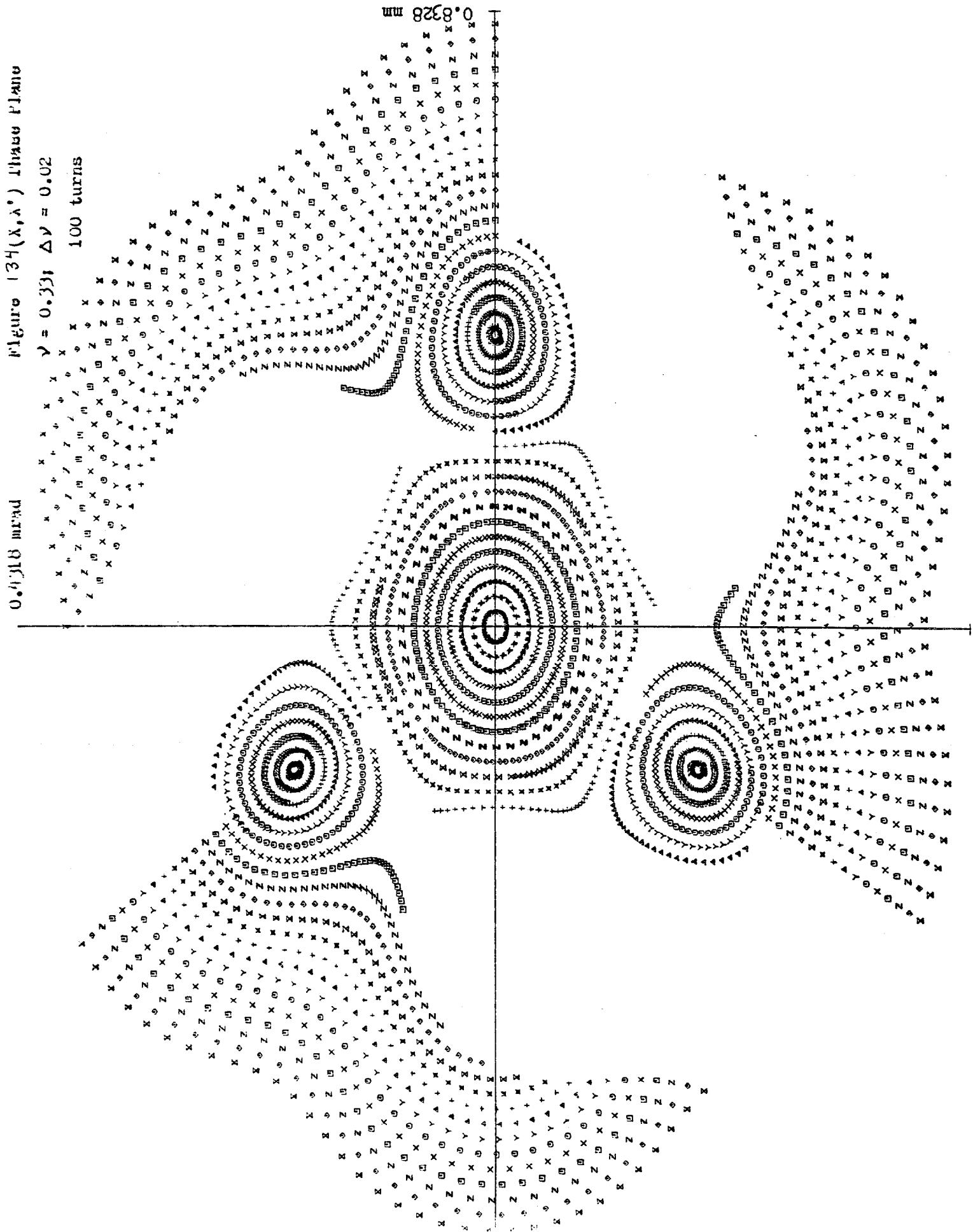


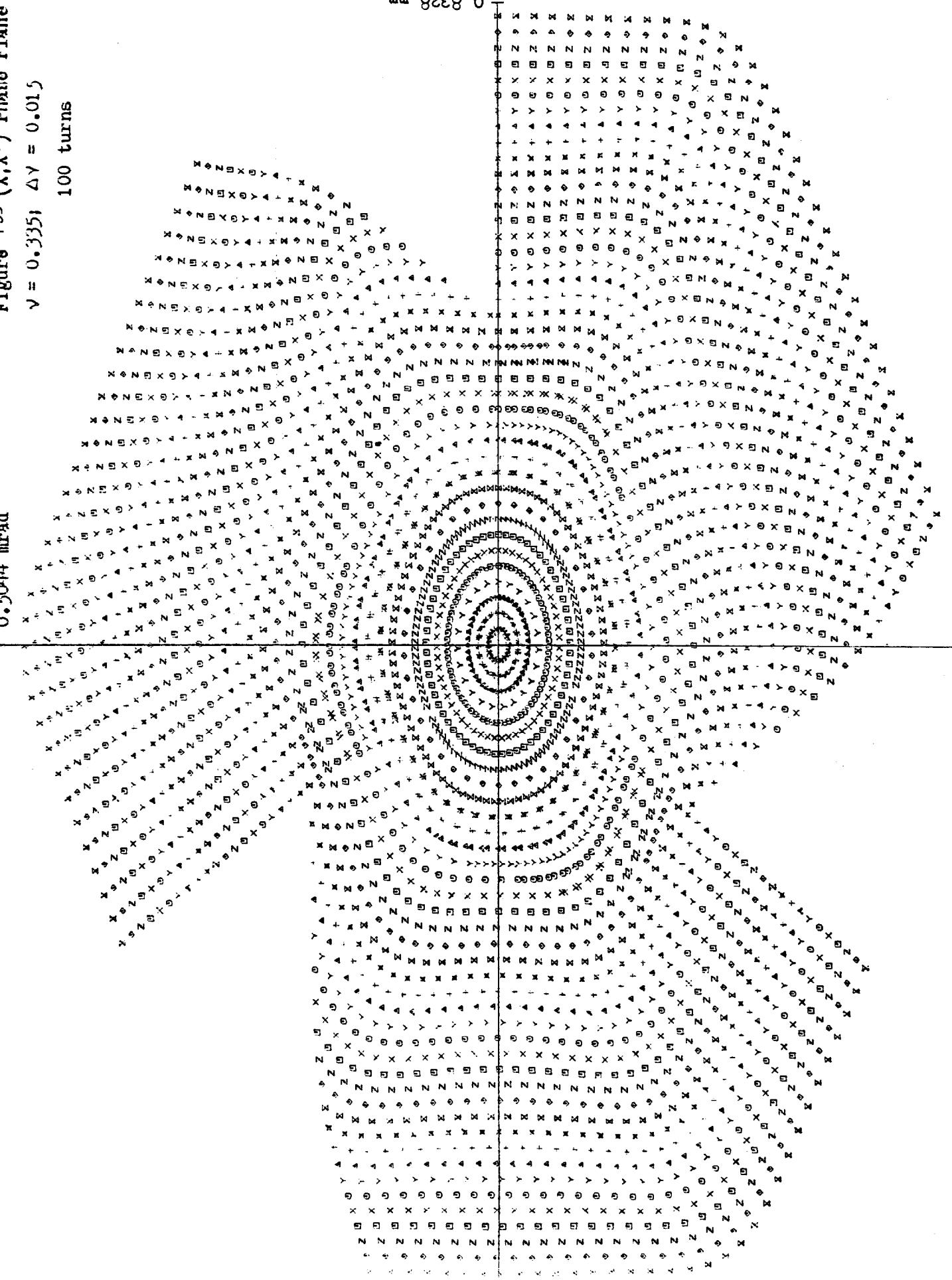
Figure 135 (X, X') Plane

$\gamma = 0.3351$, $\Delta\gamma = 0.015$

100 turns

0.5004 mm rad

0.8328 mm



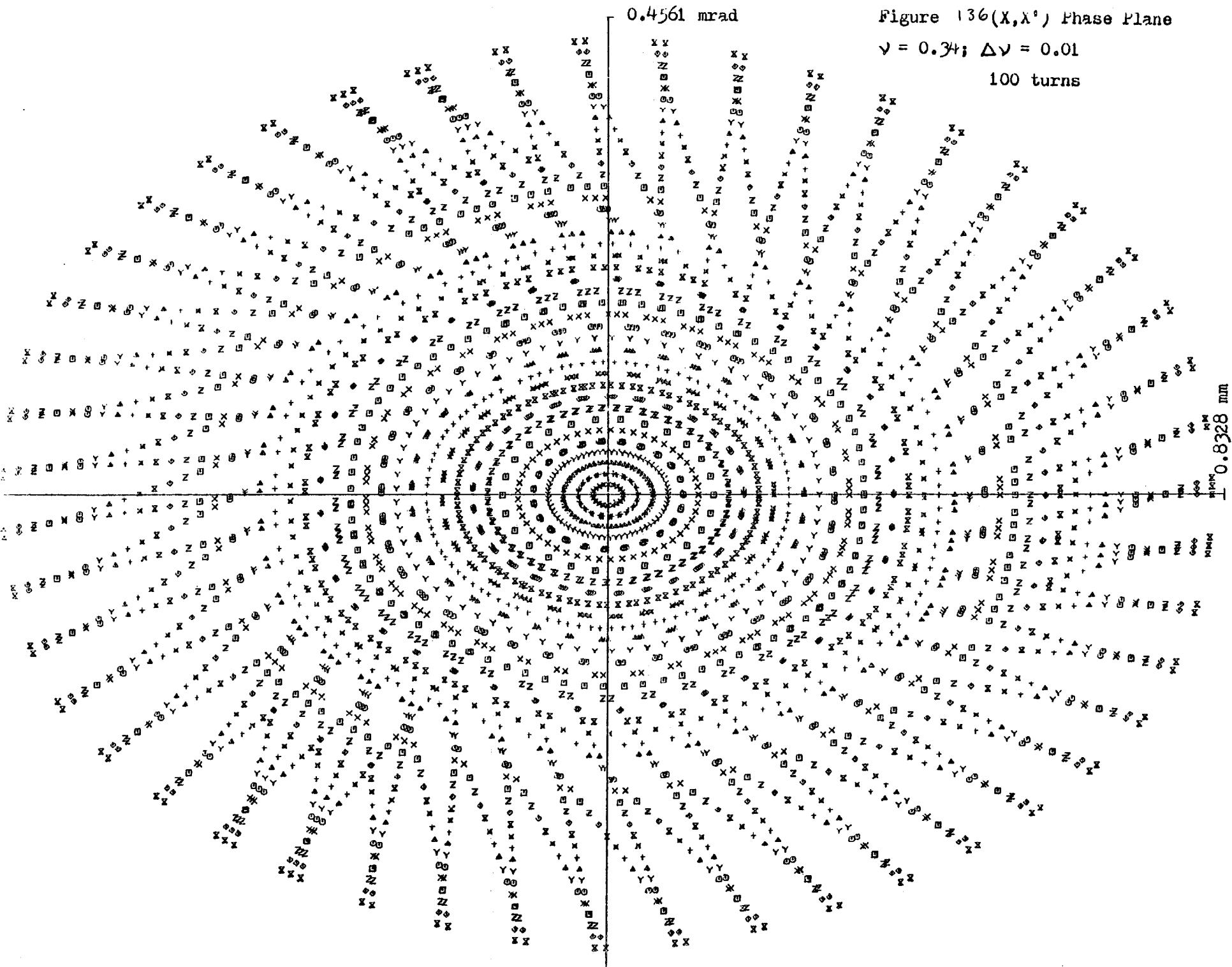


Figure | 36

Figure 137
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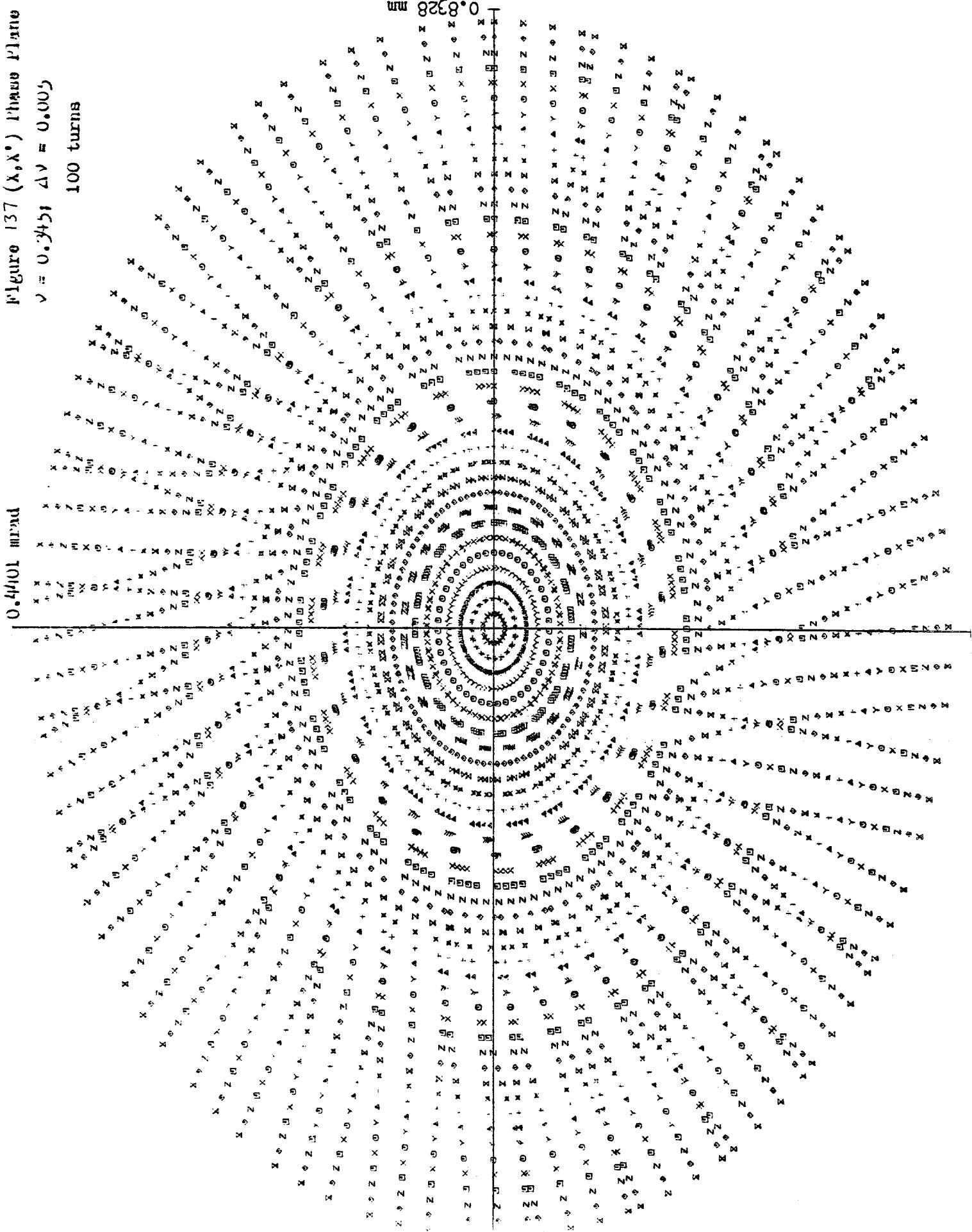


Figure 138

0.8328 mm

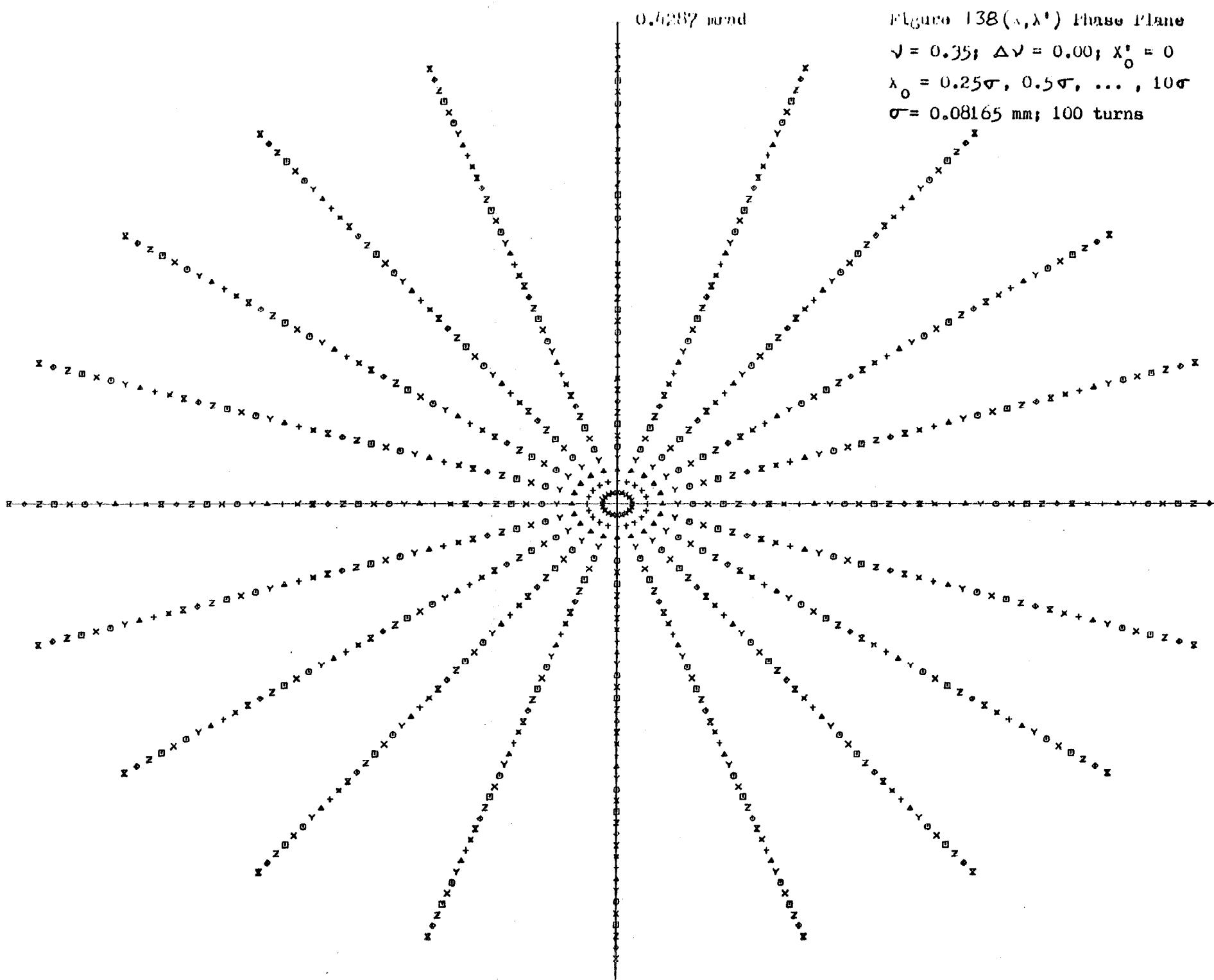
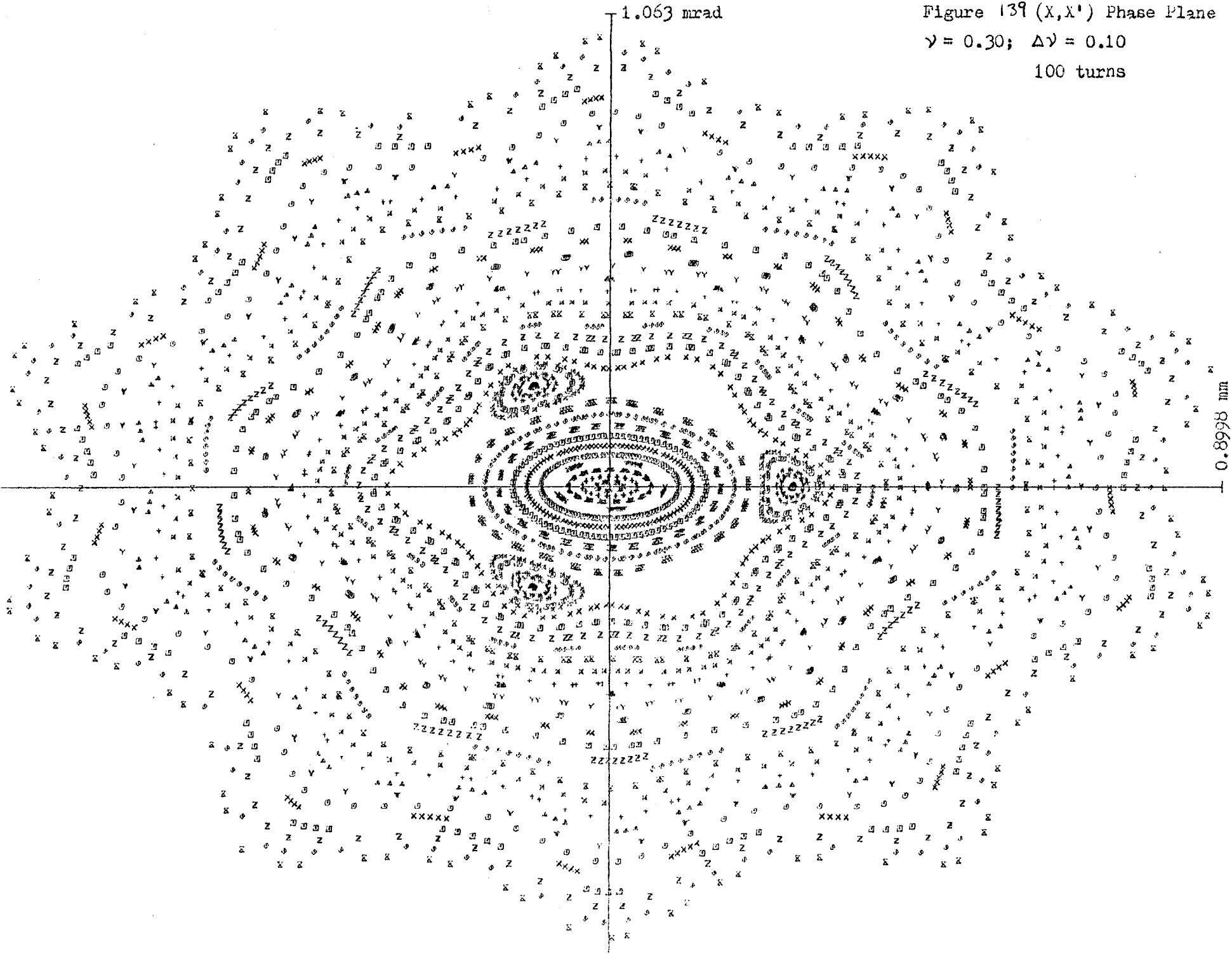
Figure 138 (λ, λ^1) Phase Plane $\lambda = 0.35; \Delta \lambda = 0.00; \lambda_0^1 = 0$ $\lambda_0 = 0.25\sigma, 0.5\sigma, \dots, 10\sigma$ $\sigma = 0.08165 \text{ mm}; 100 \text{ turns}$

Figure 139 (X, X') Phase Plane
 $\gamma = 0.30; \Delta\gamma = 0.10$
100 turns

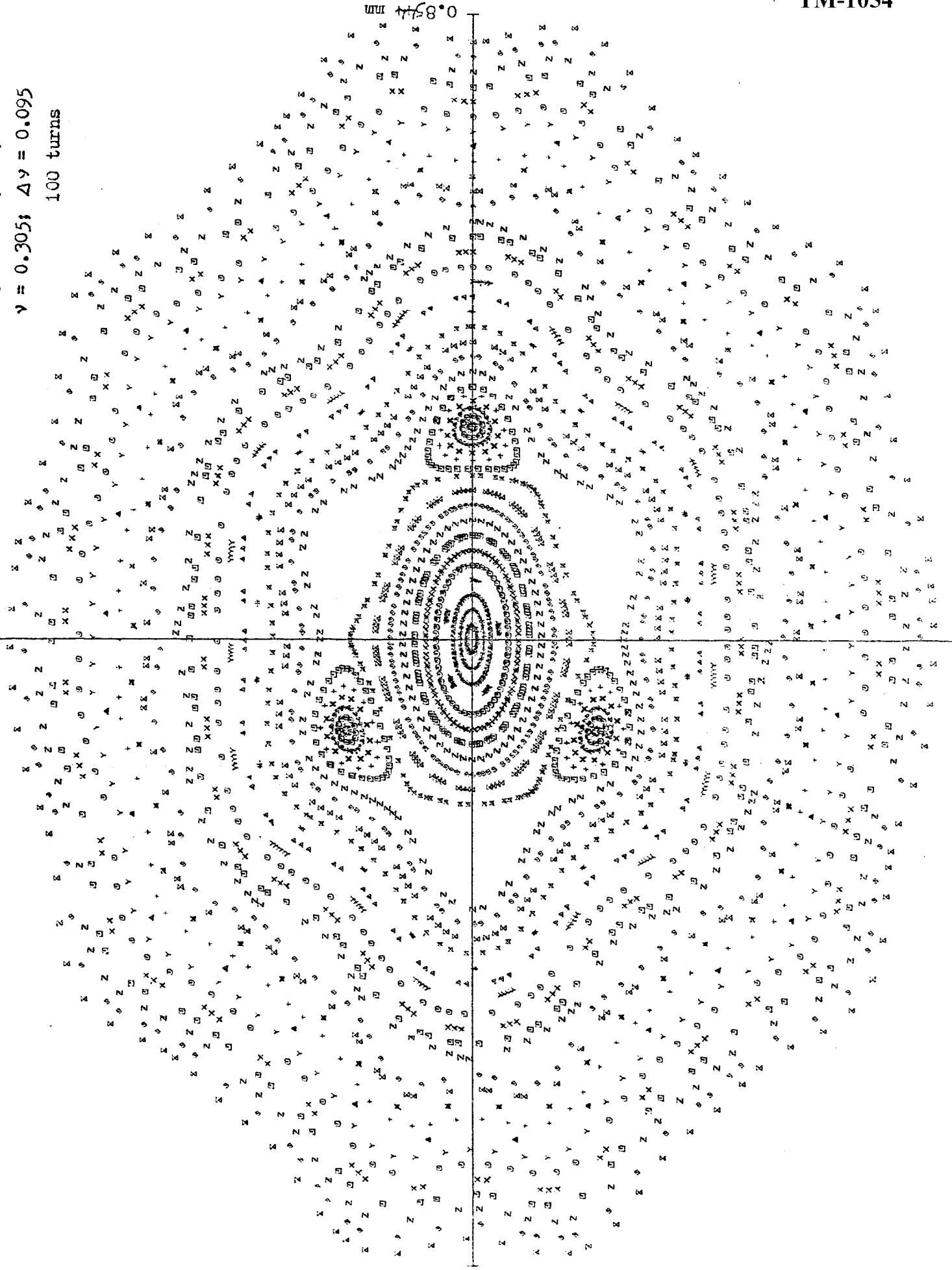


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Figure 140 (X_1, X_2) Phase Plane

$$\nu = 0.305; \Delta y = 0.095$$

100 turns

 $T = 0.9222$ mrad

0.8437 mrad

Figure 141 (X, X') Phase Plane

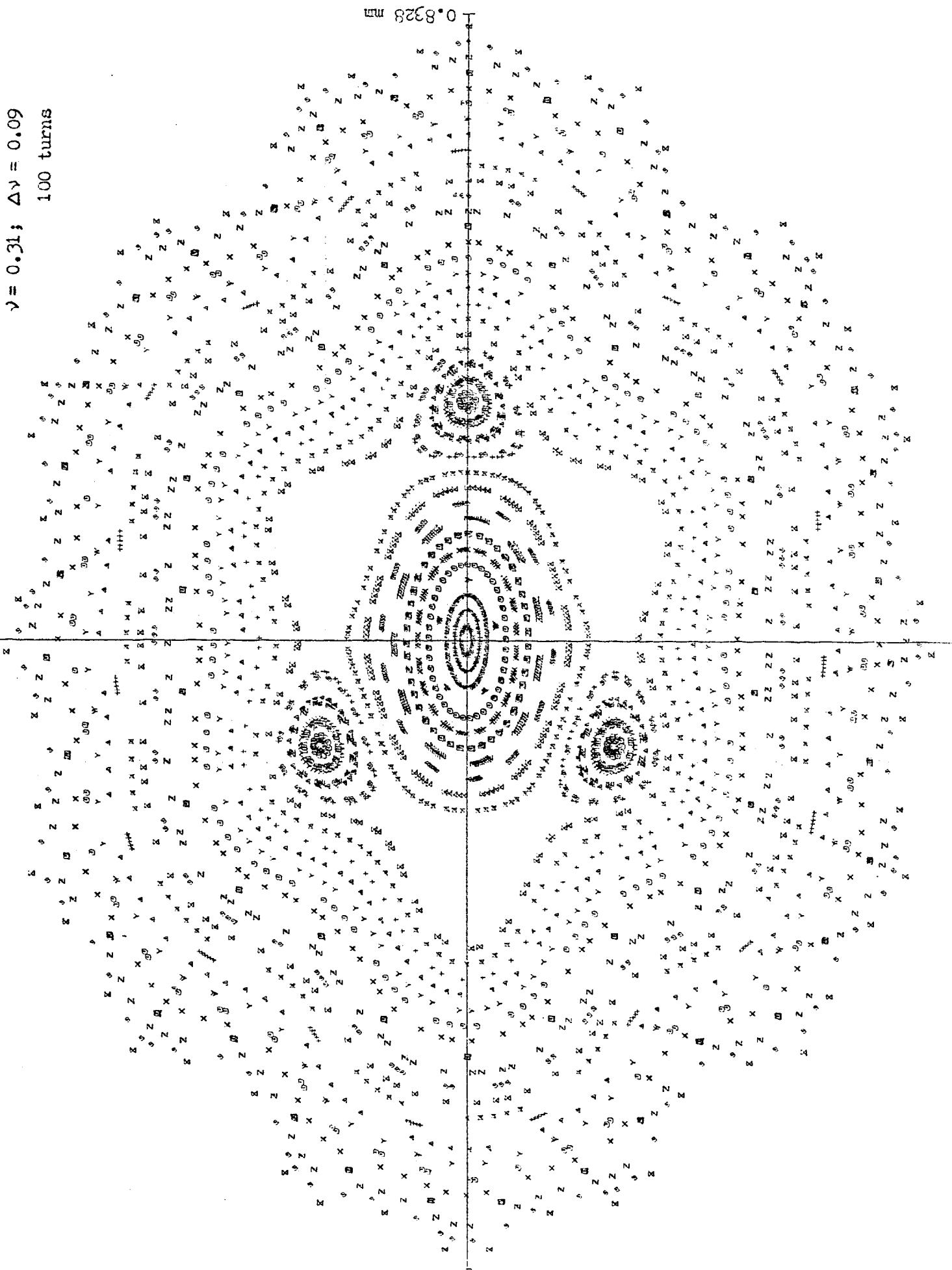


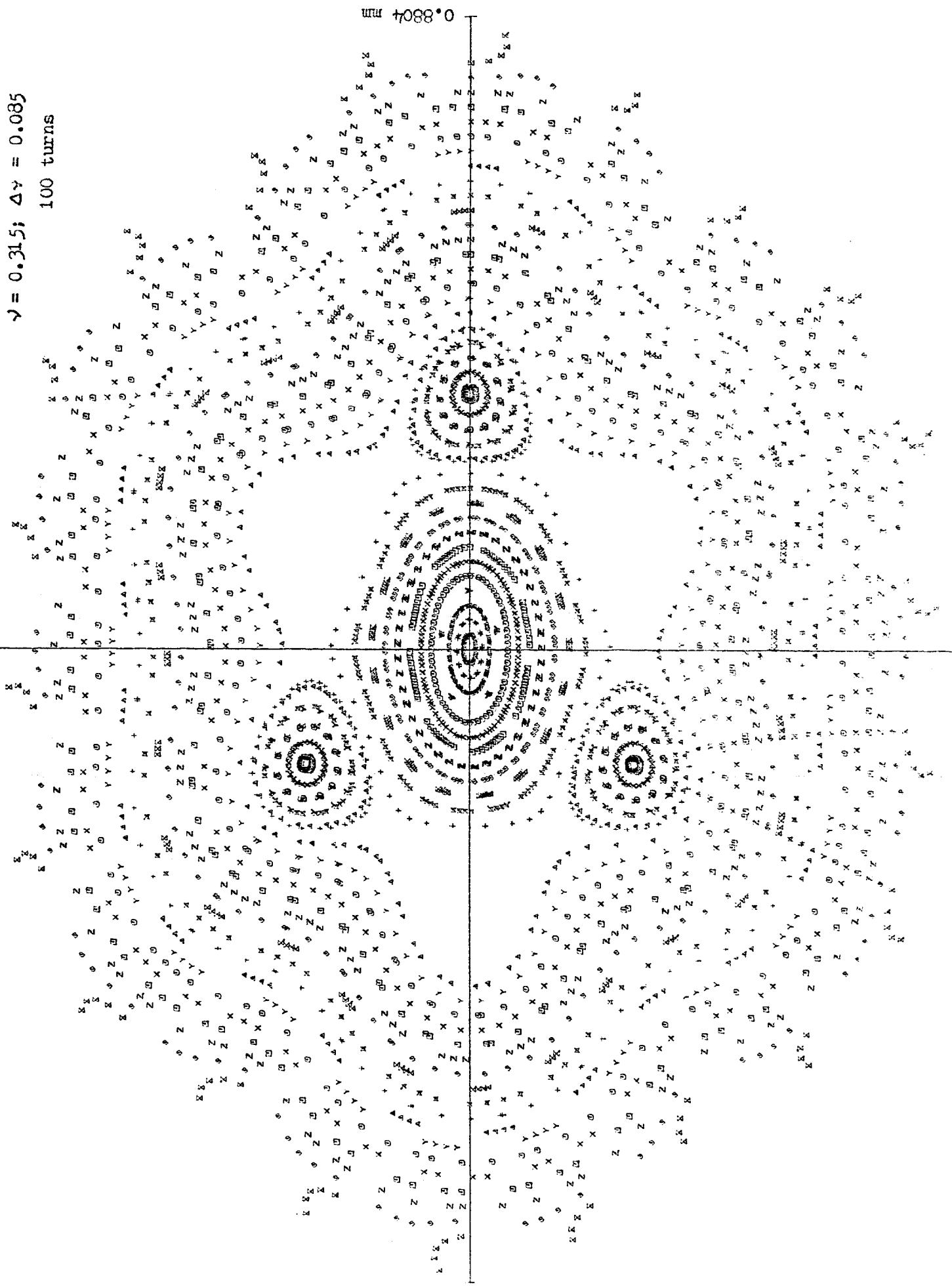
Figure 142 (X, X') Phase Plane $T = 0.8372 \text{ mrad}$ 

Figure 143 (X,X') Phase Plane

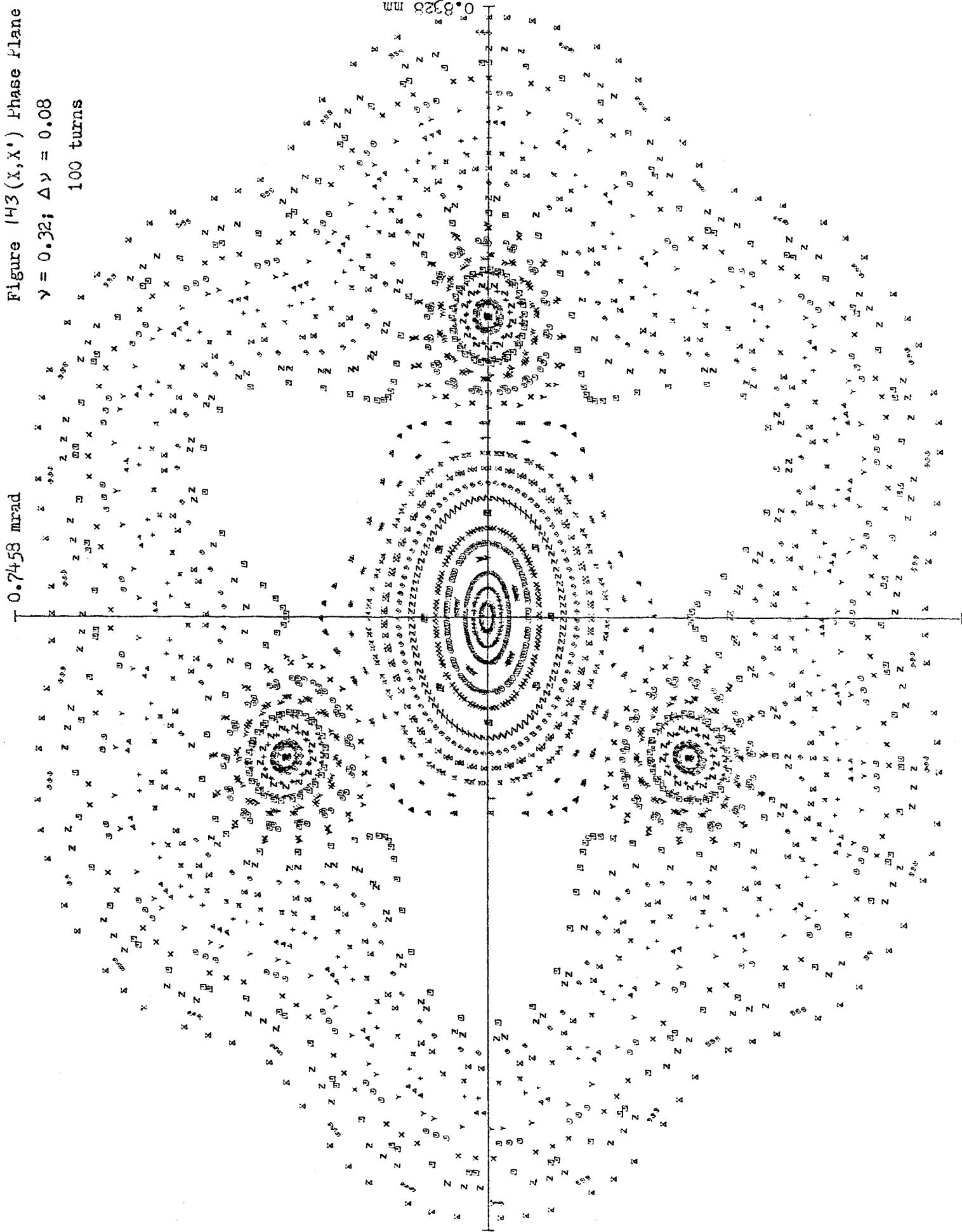
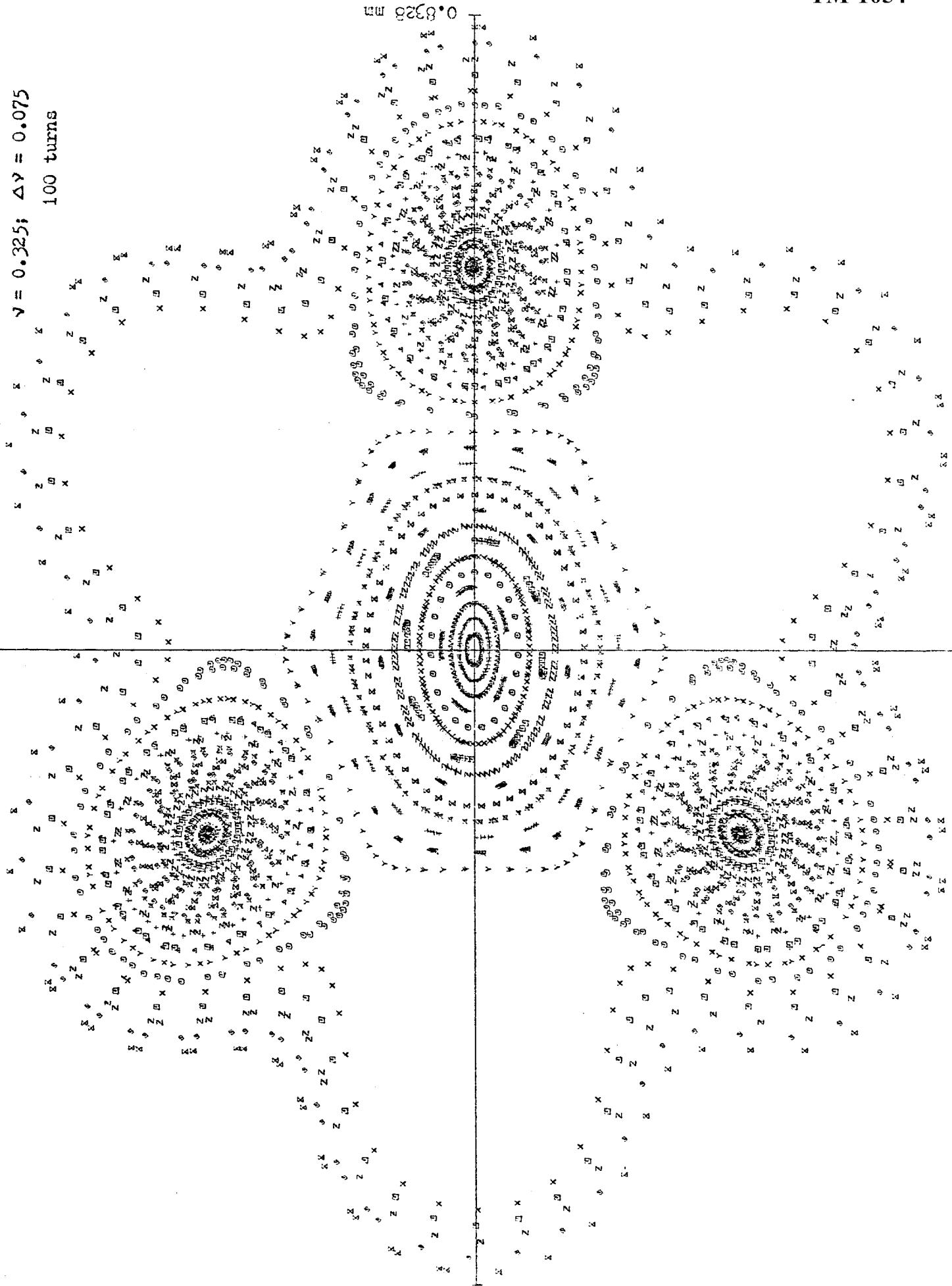


Figure 144 (X, X') Phase Plane

T 0.7047 mrad

Figure 144 (X, X') Phase Plane $\gamma = 0.325; \Delta Y = 0.075$

100 turns

Figure 145
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$T = 1.003 \text{ mrad}$

Figure 145(x, x') Phase Plane
 $\gamma = 0.33; \Delta\vartheta = 0.07; x'_0 = 0$
 $x_0 = 0.25\sigma, 0.5\sigma, \dots, 10\sigma$
 $\sigma = 0.08165 \text{ mm}; 100 \text{ turns}$

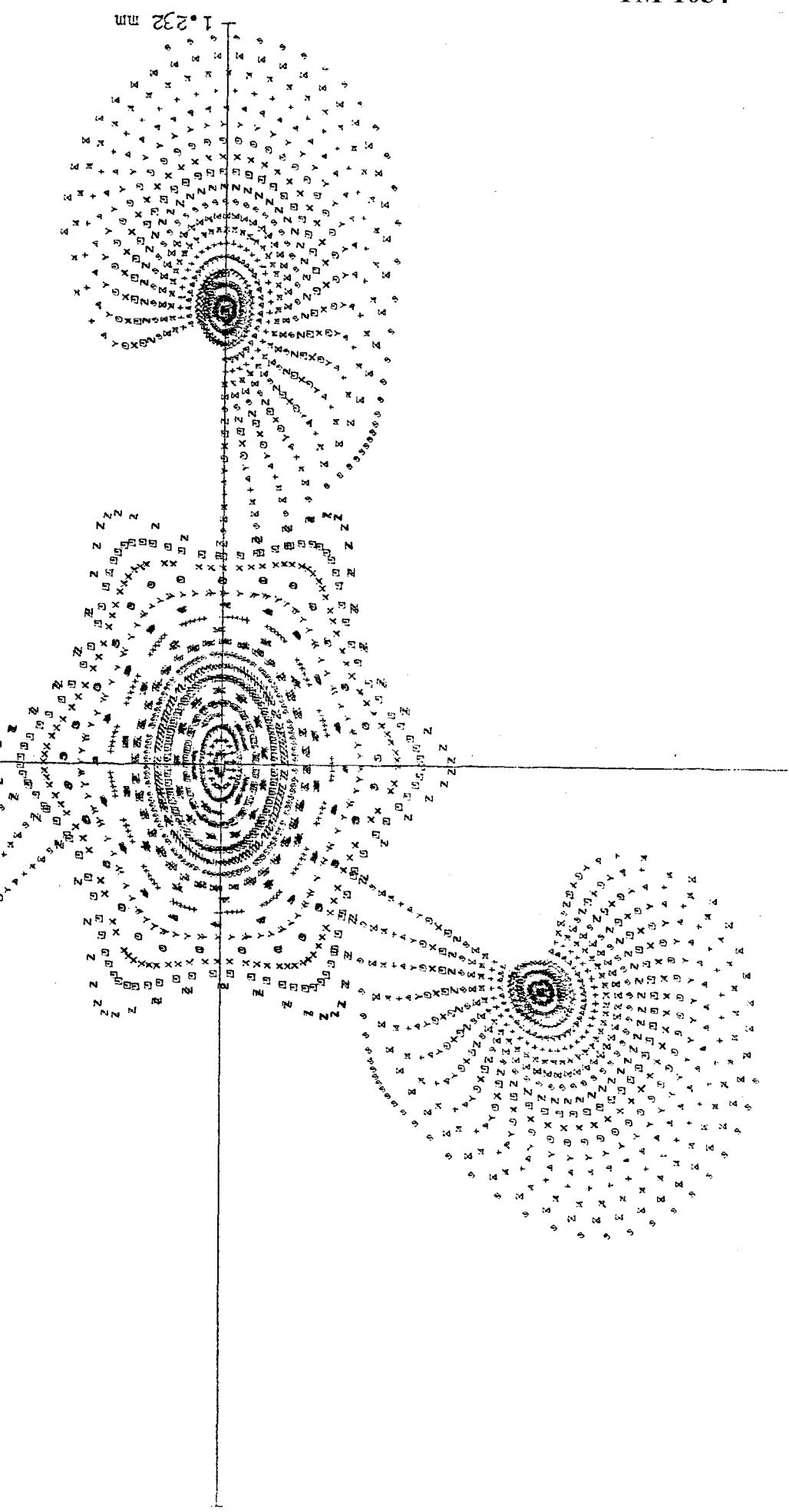


Figure 146 (X, X') Phase Plane
 $v = 0.335; \Delta v = 0.065$
100 turns

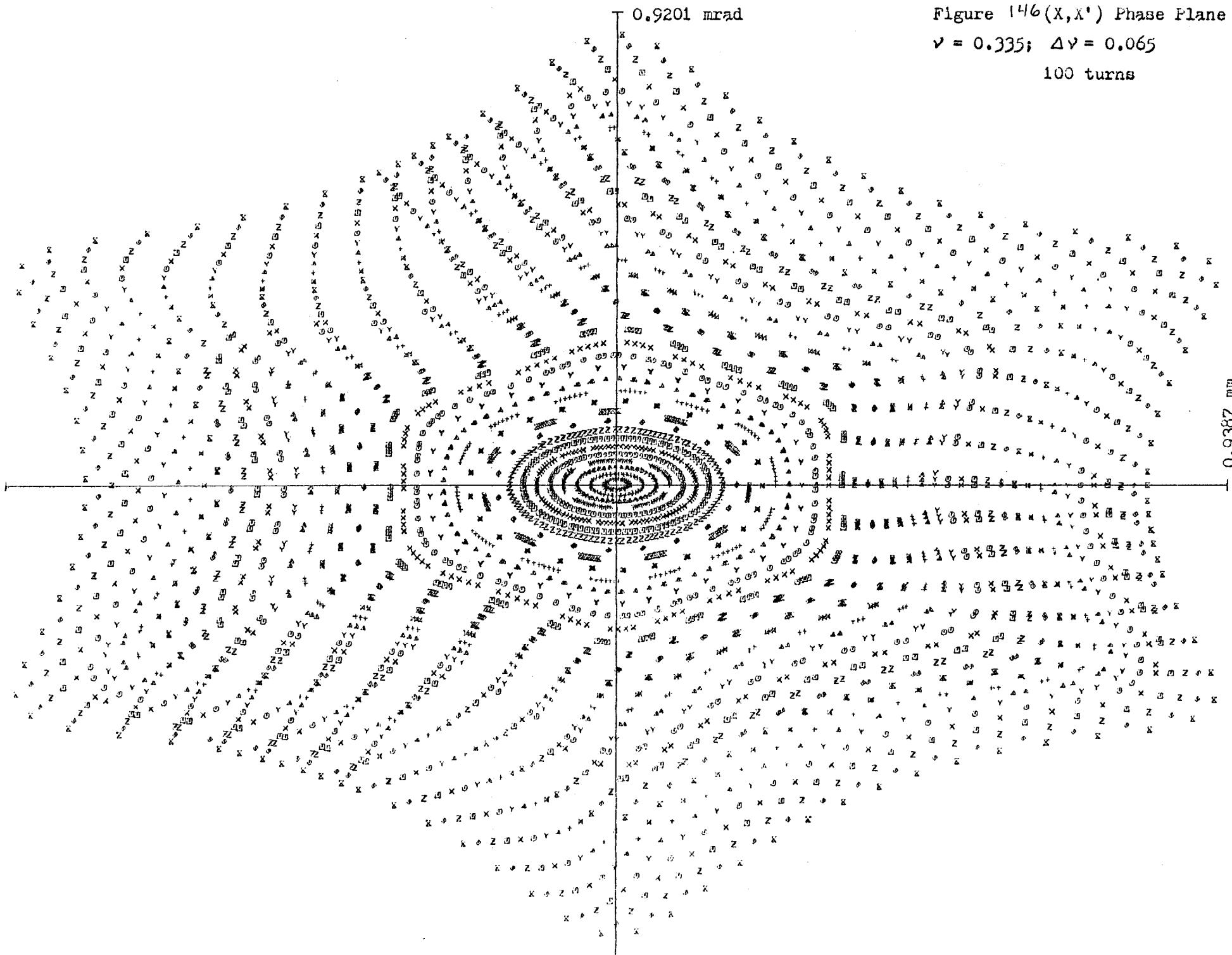
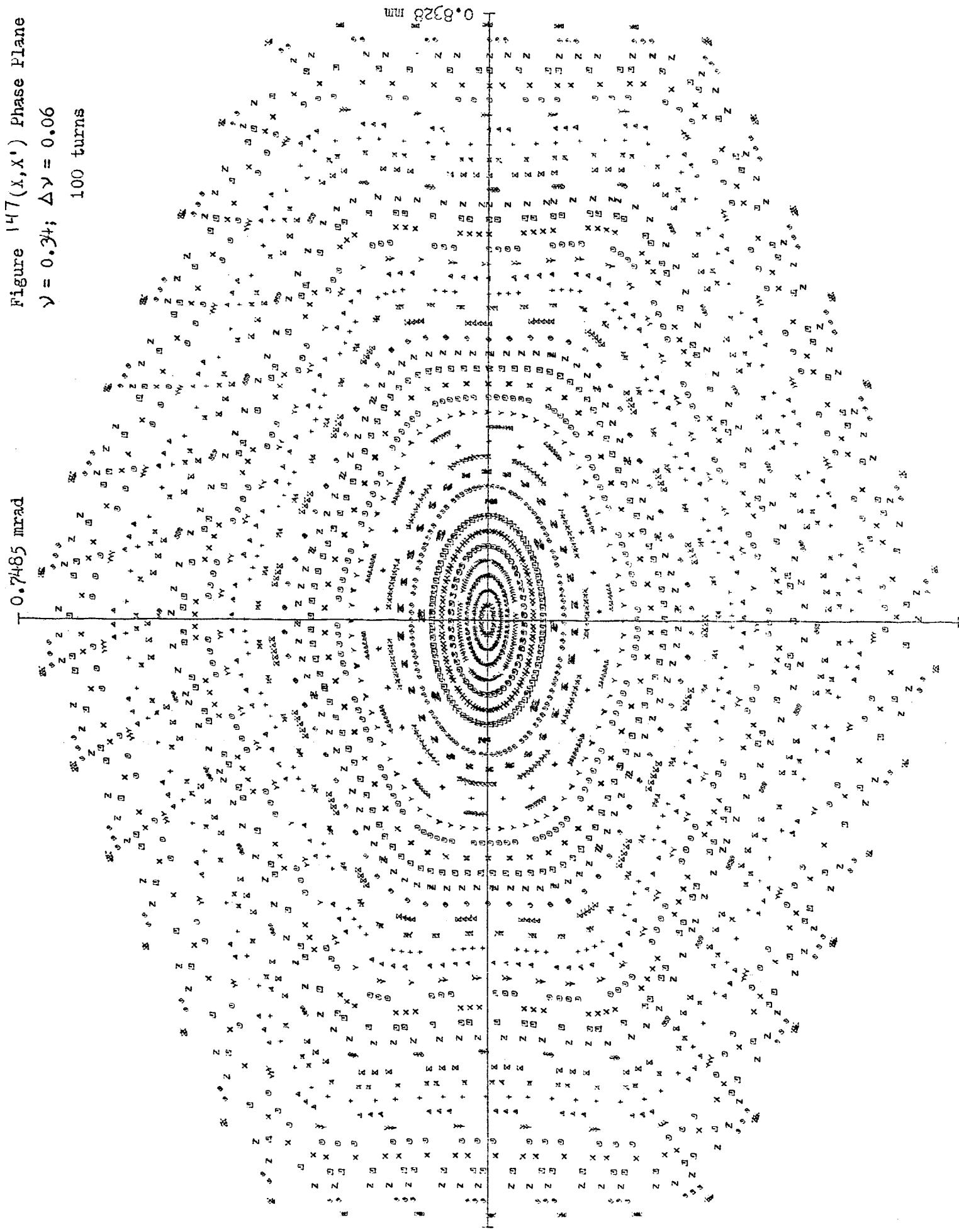


Figure 147(X, X') Phase Plane

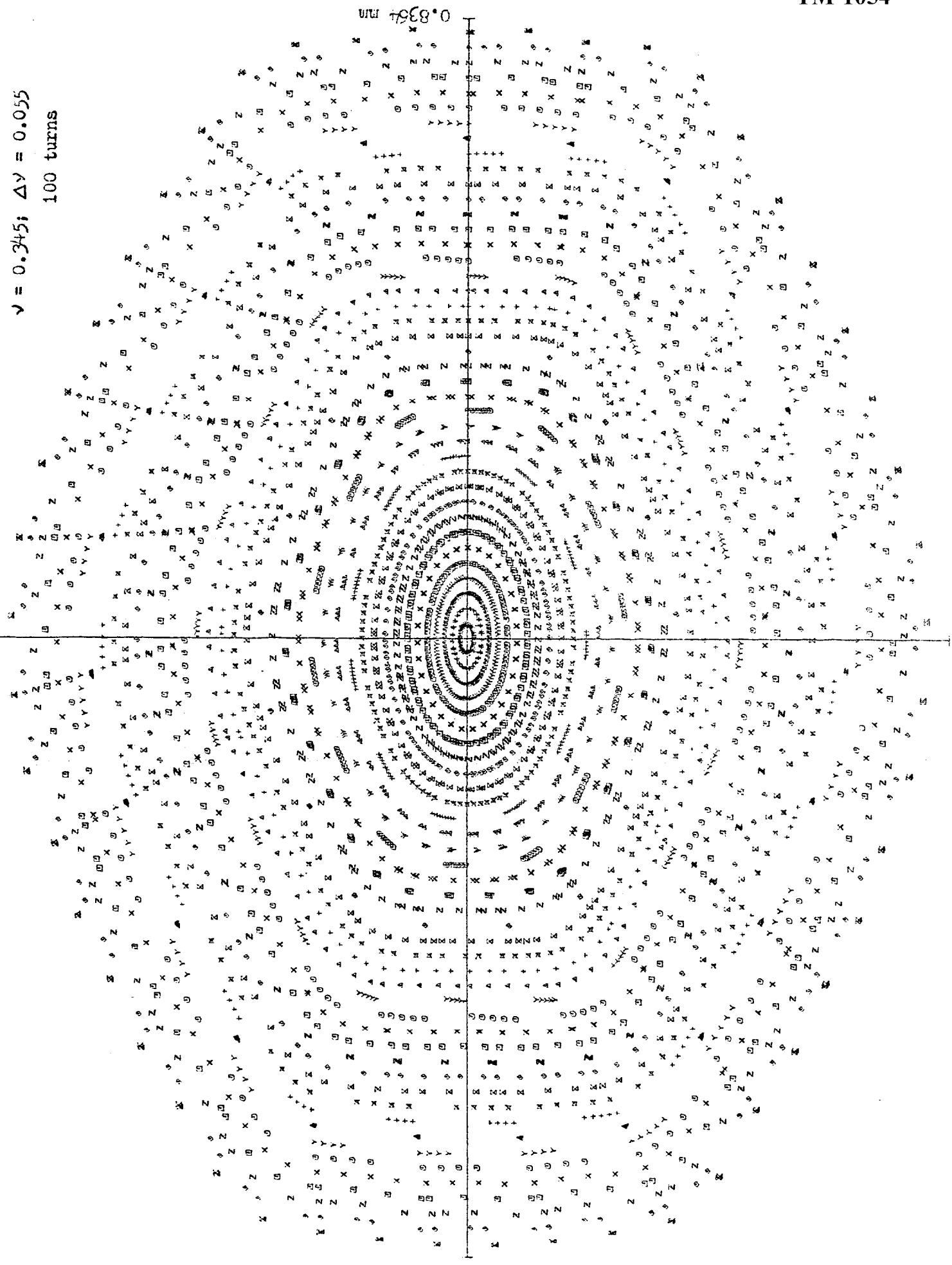
$\gamma = 0.34; \Delta\gamma = 0.06$
100 turns

T 0.7485 mrad

0.8328 mm



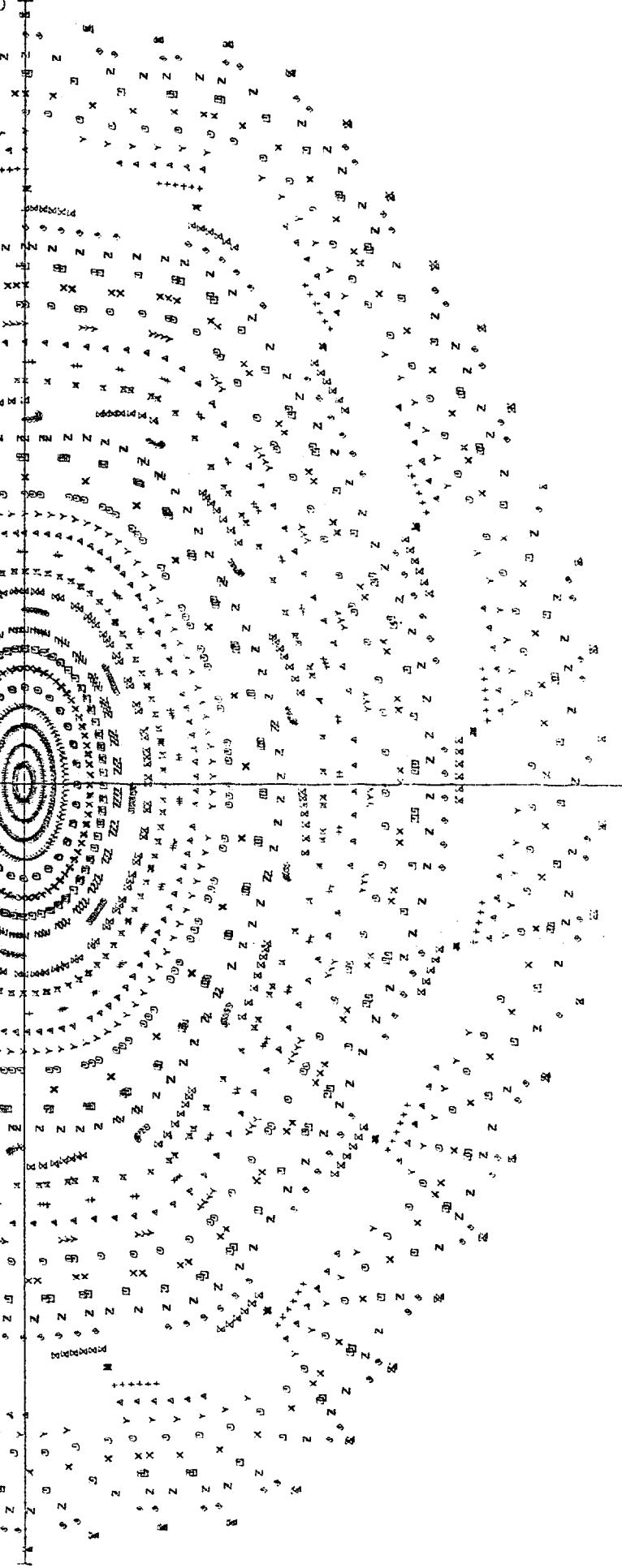
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Figure 148 (X, X') Phase Plane $T = 0.6954$ mrad

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Figure 149 (X, X') Phase Plane $\Gamma = 0.6450 \text{ mrad}$
 $\gamma = 0.35; \Delta\gamma = 0.05$
 100 turns

0.8328 m



TM-1054

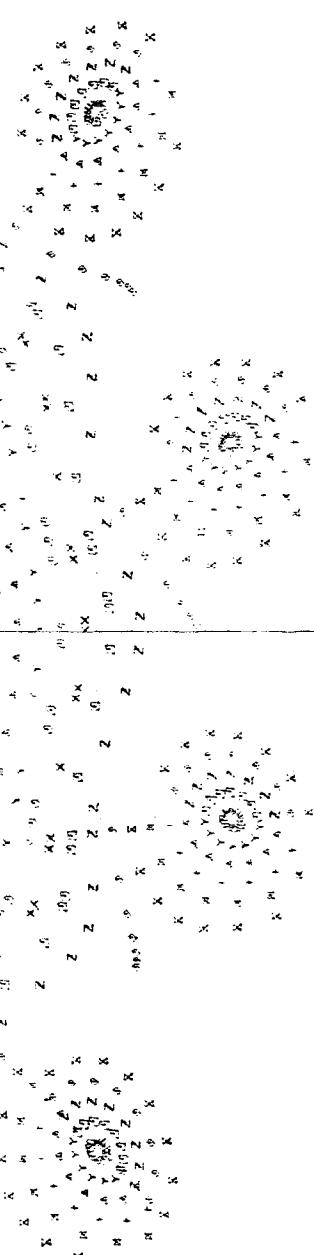
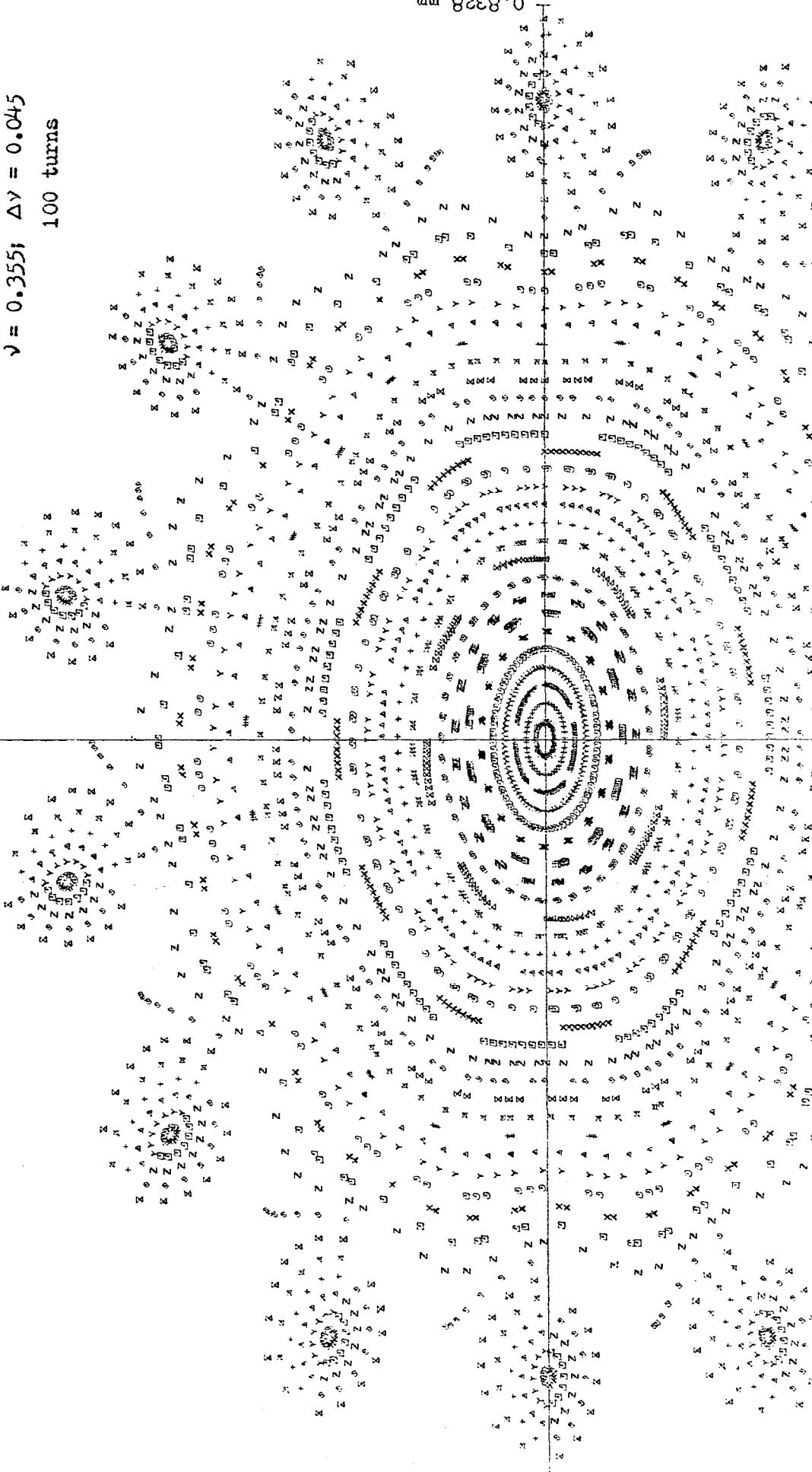
0.8328 MM

Figure 150 (X,X') Phase Plane

T 0.6032 mrad

 $\nu = 0.355$; $\Delta\nu = 0.045$

100 turns



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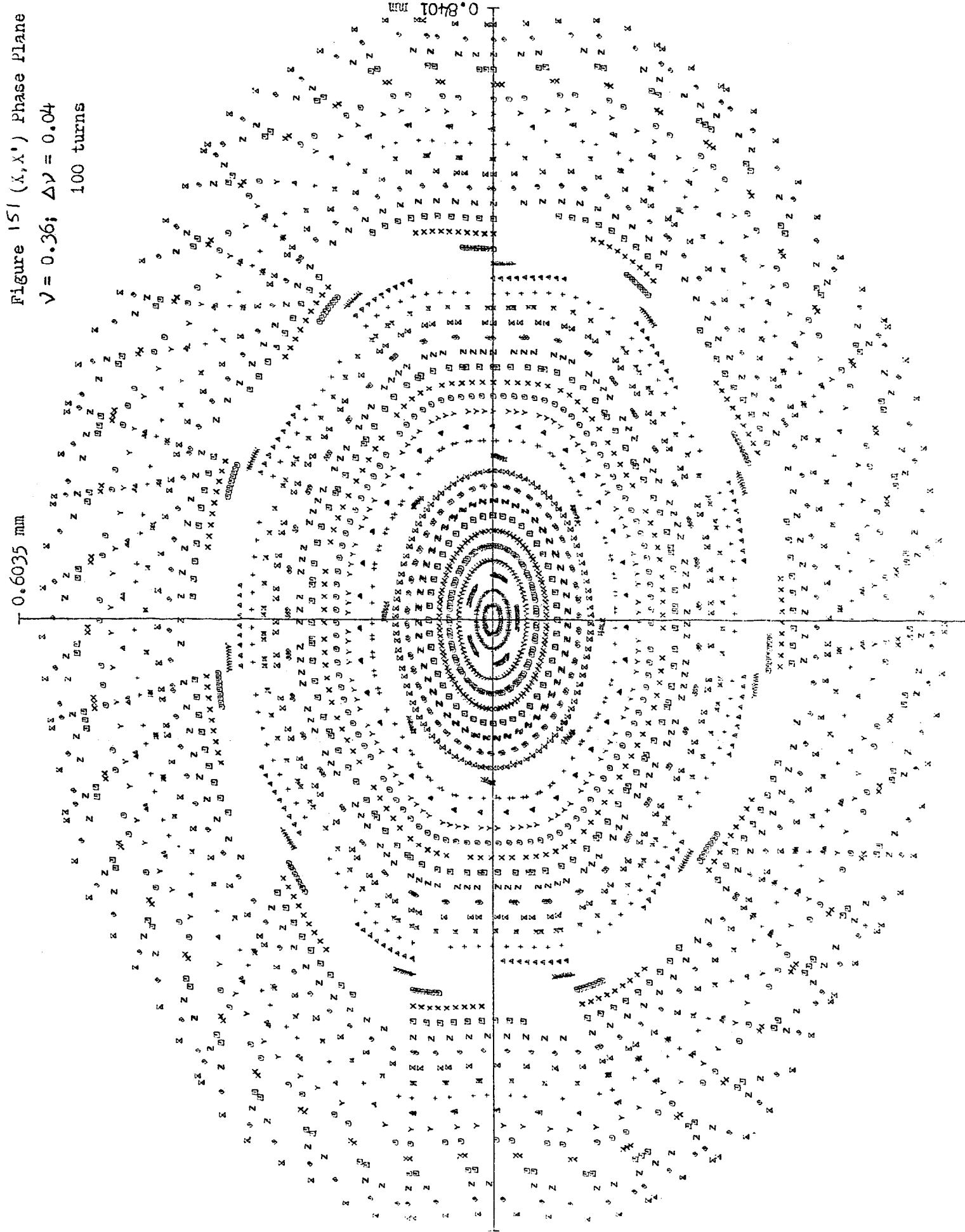


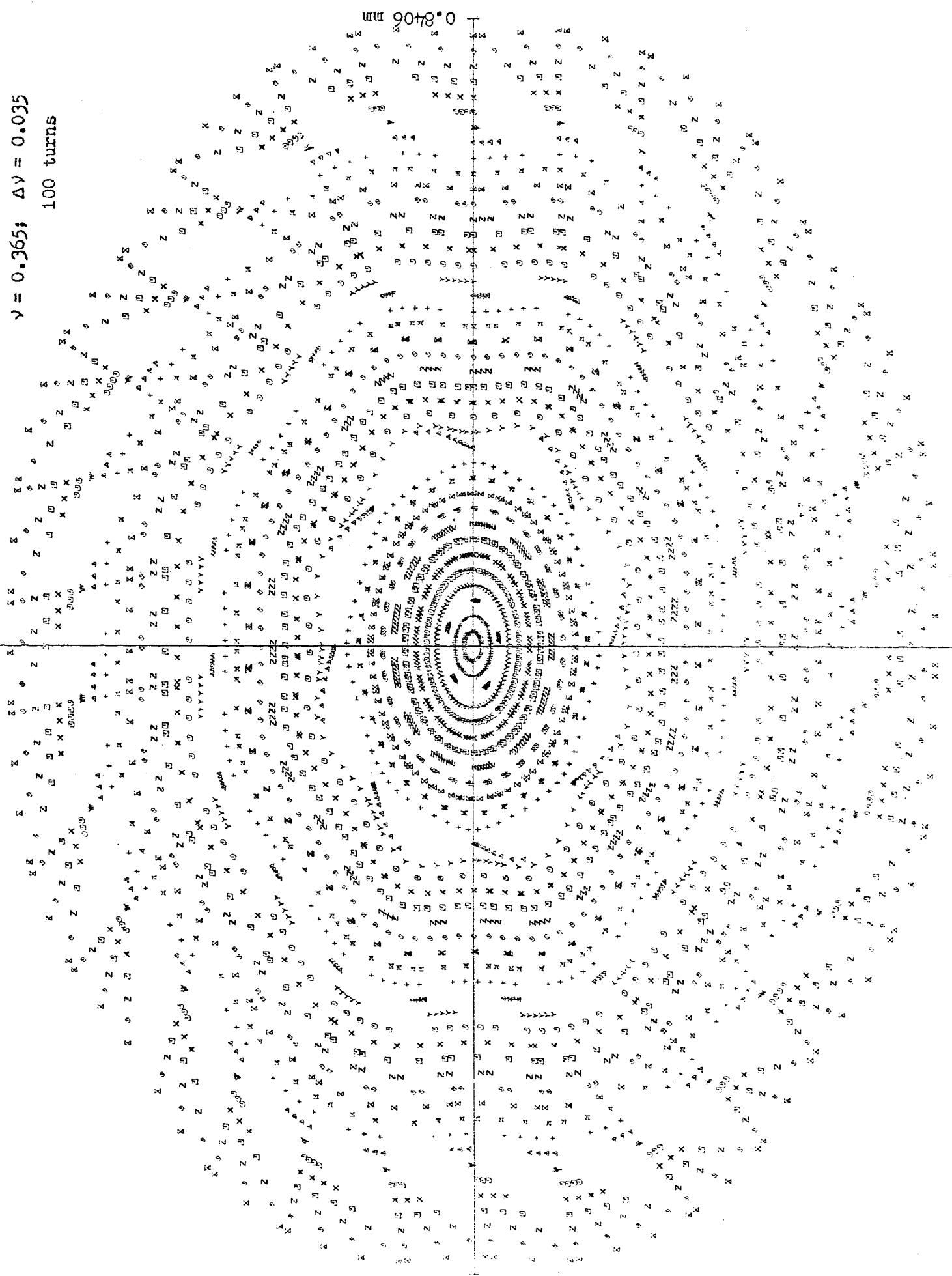
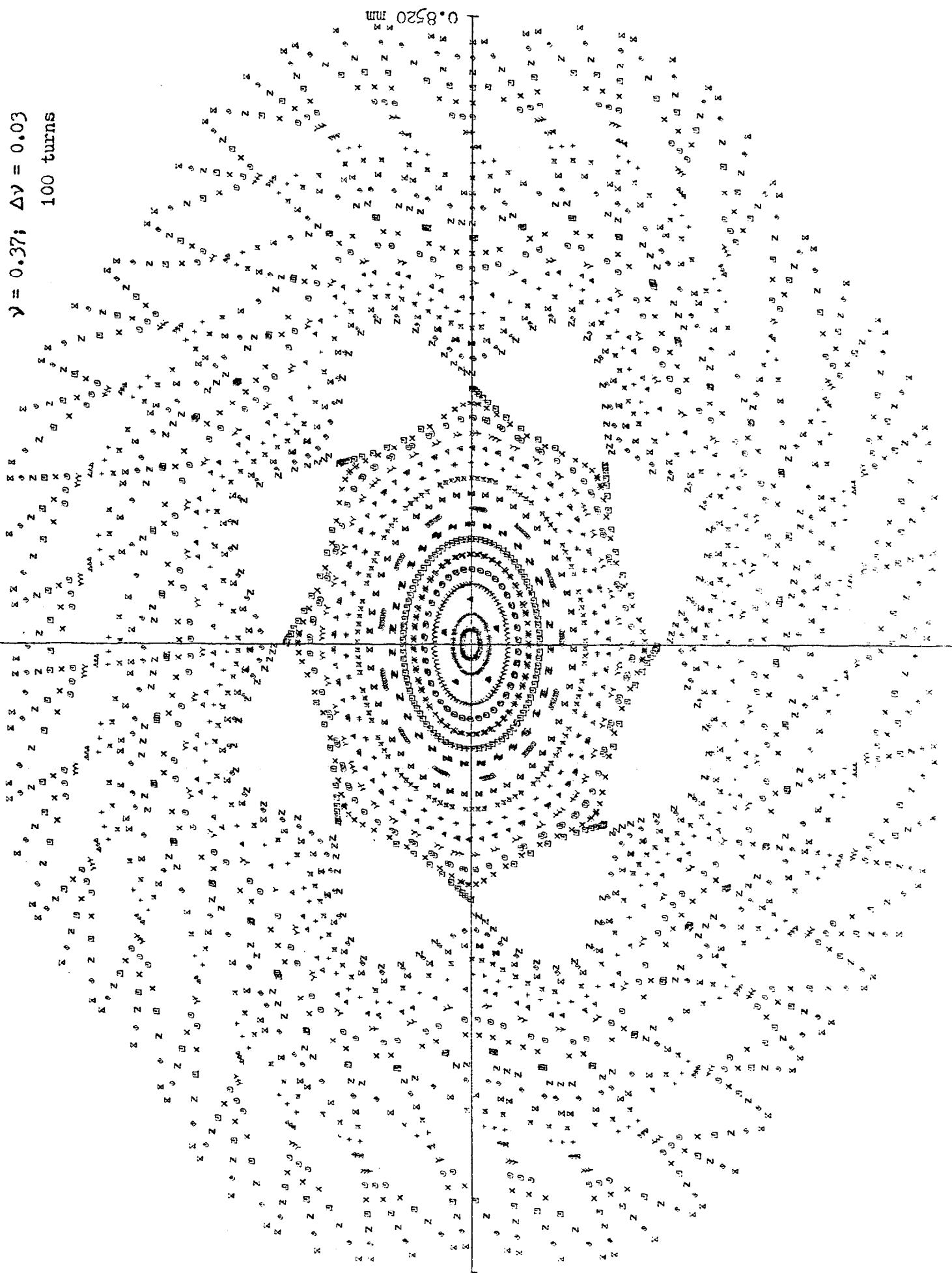
Figure 152 (X, λ') Phase Plane $T = 0.5740 \text{ mrad}$ 

Figure 153(X, X') Phase Plane $\Gamma = 0.5564$ mrad

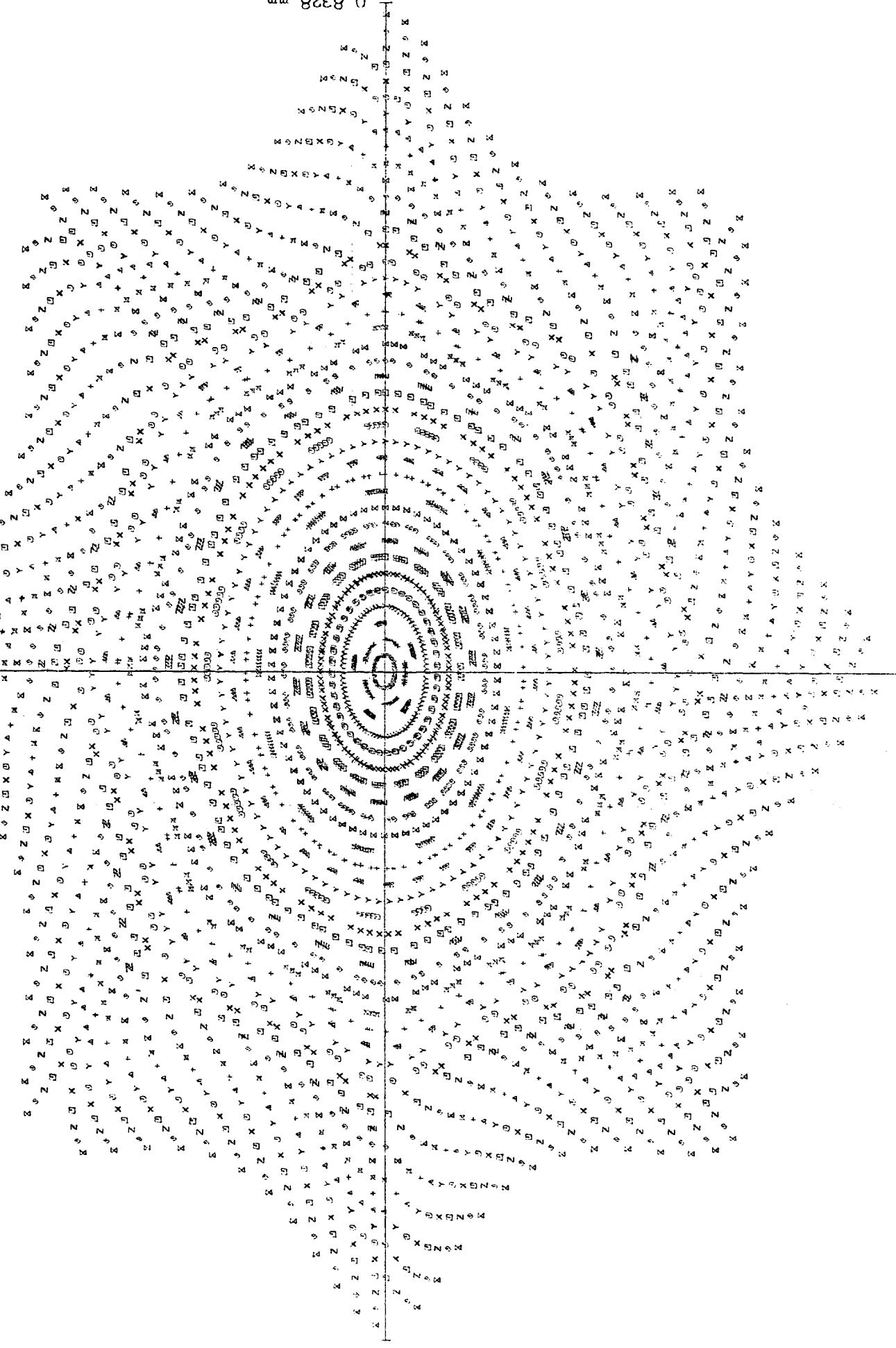
0.8328 mm

T = 0.5231 mrad

Figure 154 (χ, χ') Phase Plane

$$\nu = 0.375; \Delta\nu = 0.025$$

100 turns



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0.5014 mrad

Figure 155(X,X') Phase Plane

 $\gamma = 0.38; \Delta\psi = 0.02$

100 turns

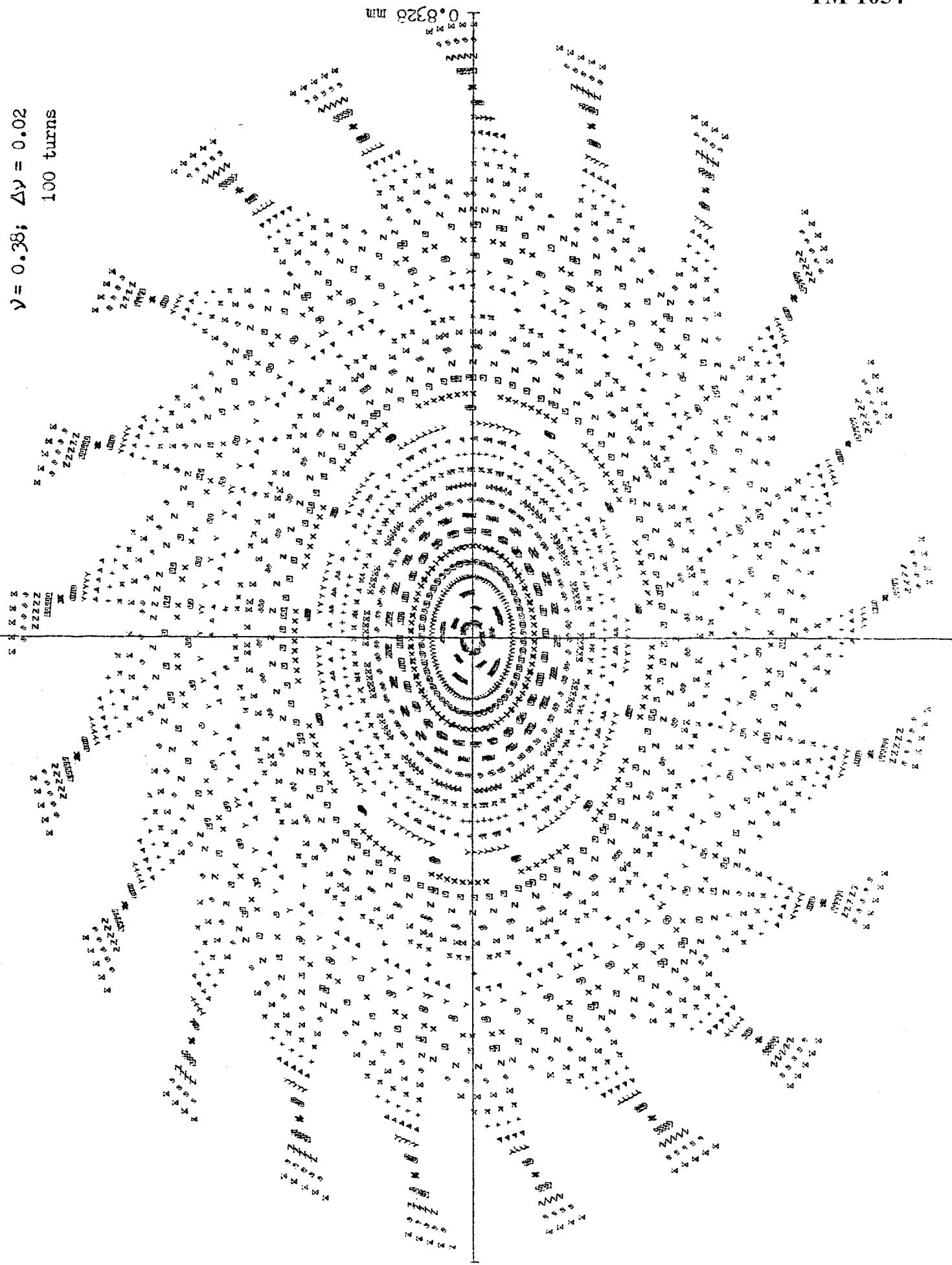


Figure 156 (X, X') Phase Plane $\gamma = 0.385; \Delta\nu = 0.015$

100 turns

T 0.4809 mrad

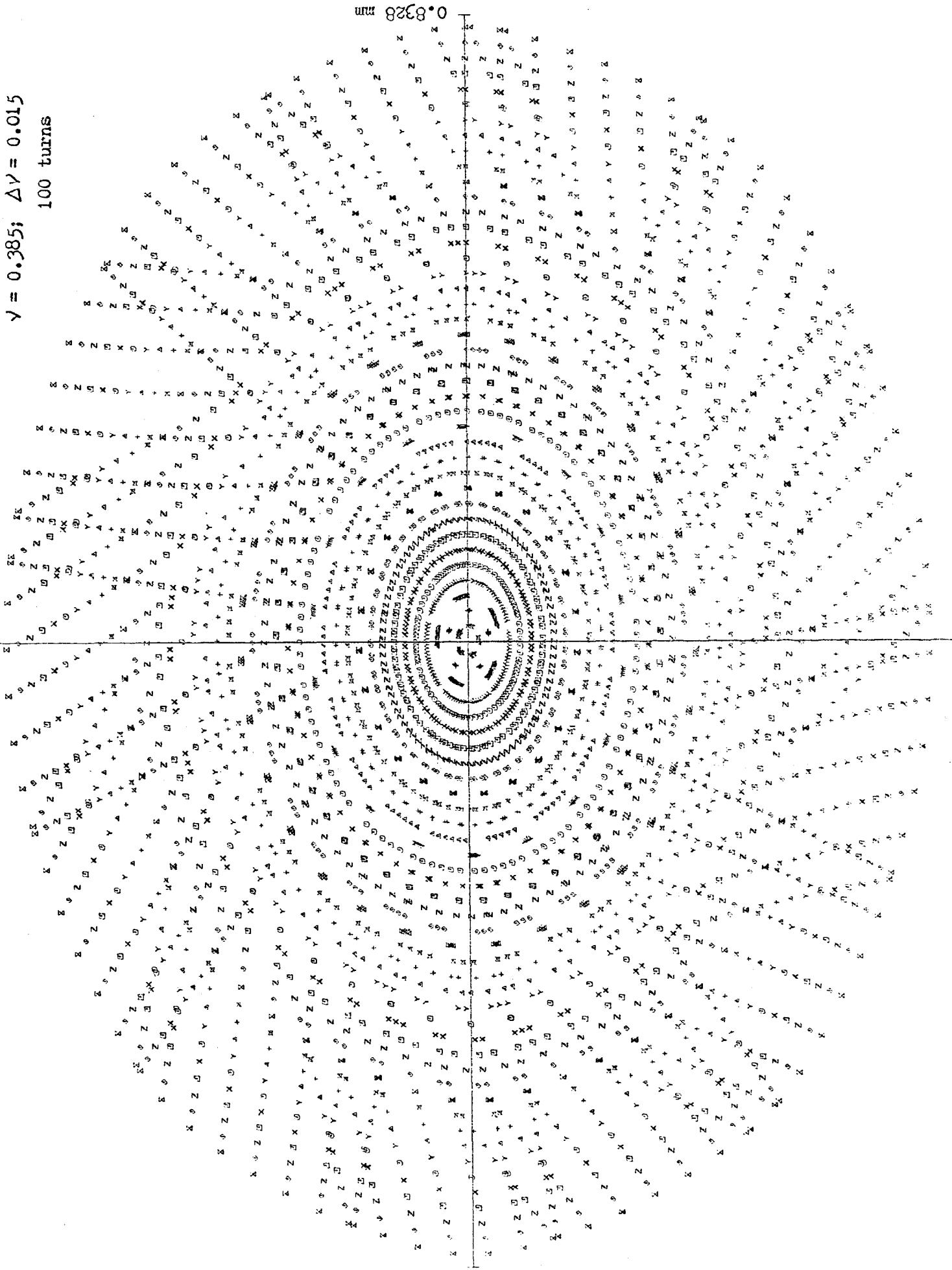
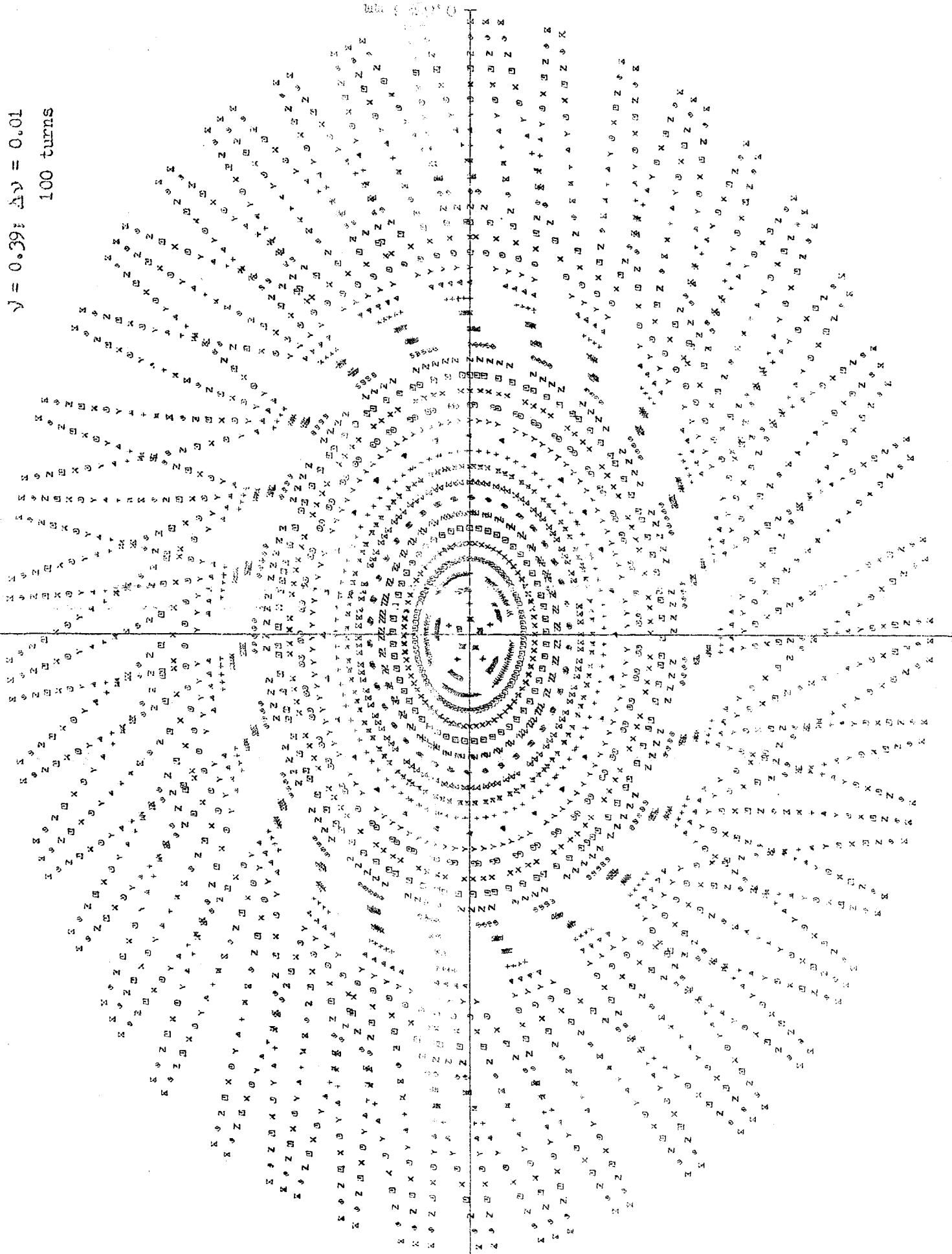


Figure 57(X, X') Phase Plane $T = 0.4645$ mrad

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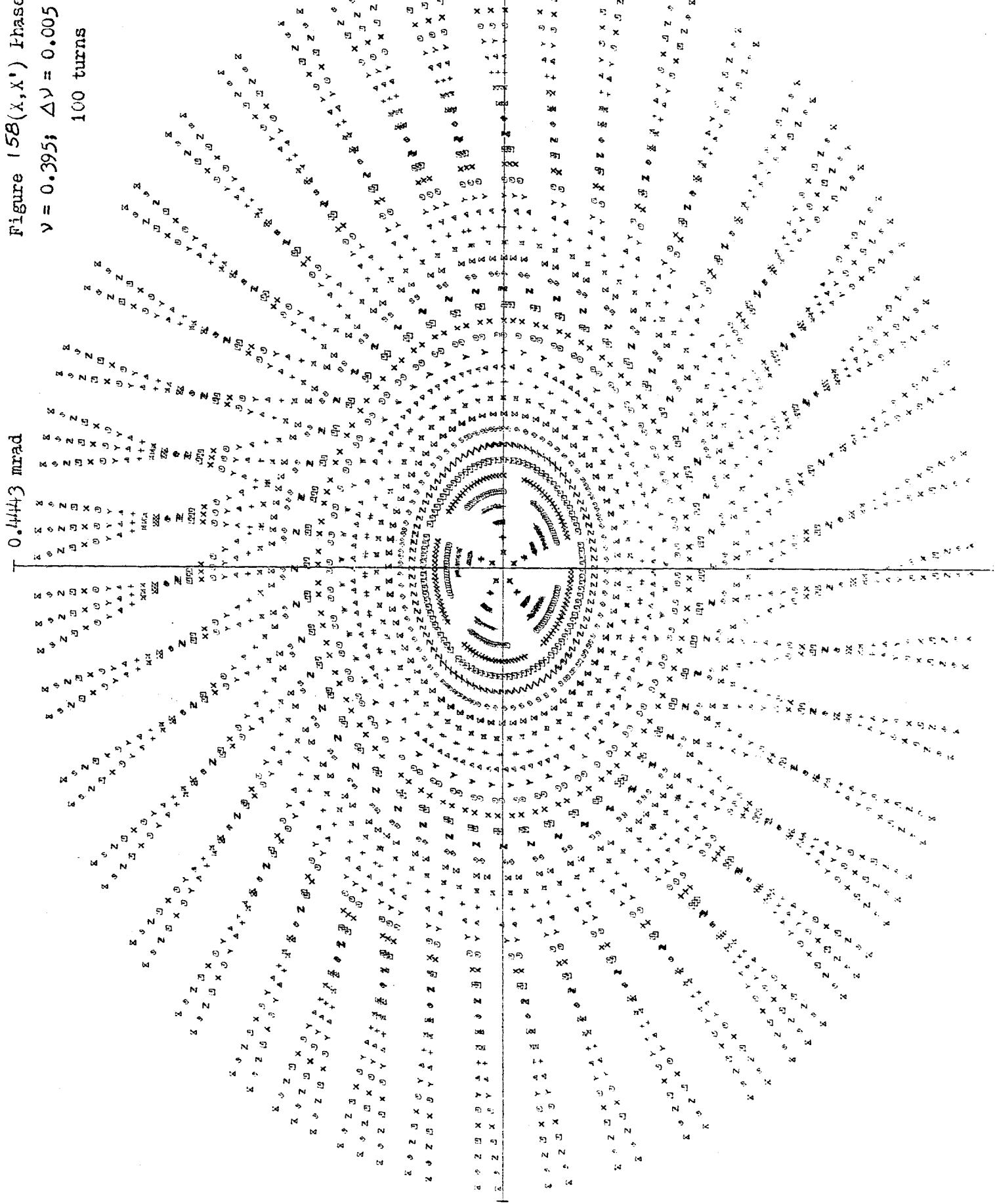
Figure 15B(X, X') Phase Plane

Figure 159 (λ, λ') Phase Plane
 $\gamma = 0.40; \Delta\gamma = 0.00; \lambda'_0 = 0$
 $\lambda_0 = 0.25\pi, 0.5\pi, \dots, 10\pi$
 $\sigma = 0.08165 \text{ mm}; 100 \text{ turns}$

T 0.4077

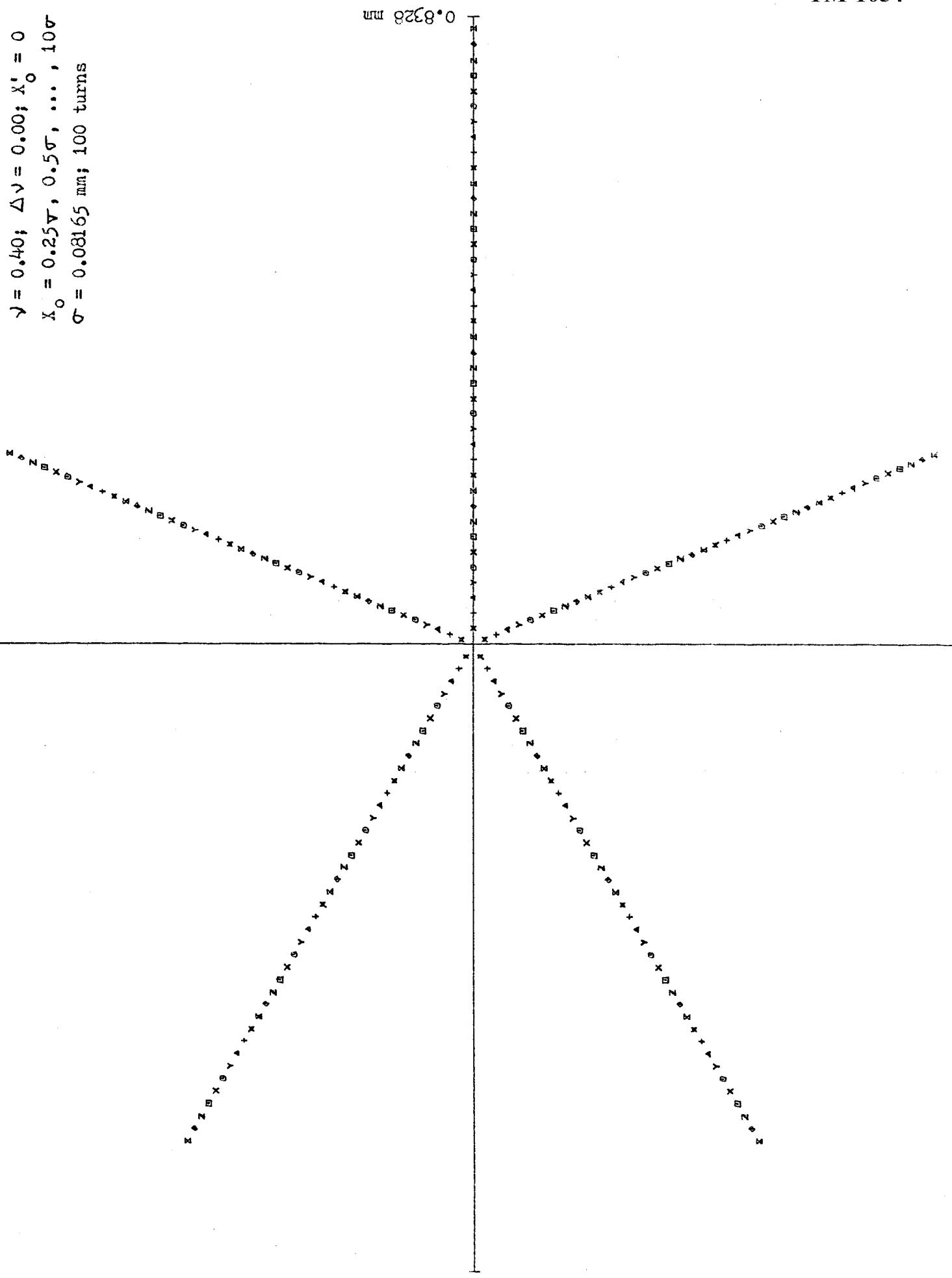


Figure 160 (λ, λ') Phase Plane

$\gamma = 0.40; \Delta v = 0.05$

100 turns

T 2.554 mrad

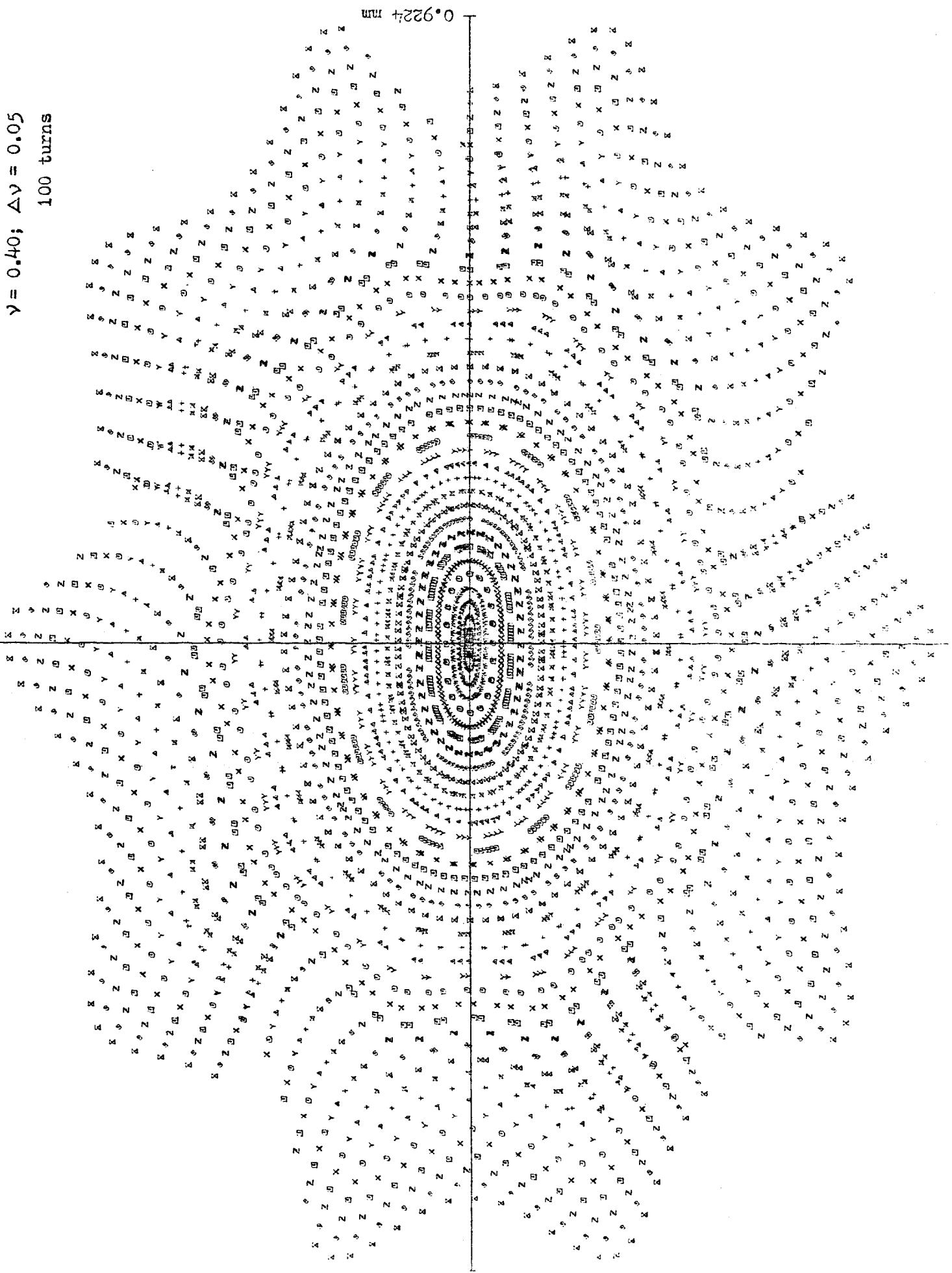


Figure 16/ (X,X') Phase Plane

 $\gamma = 1.449 \text{ mrad}$ $\gamma = 0.405; \Delta\gamma = 0.045$

100 turns

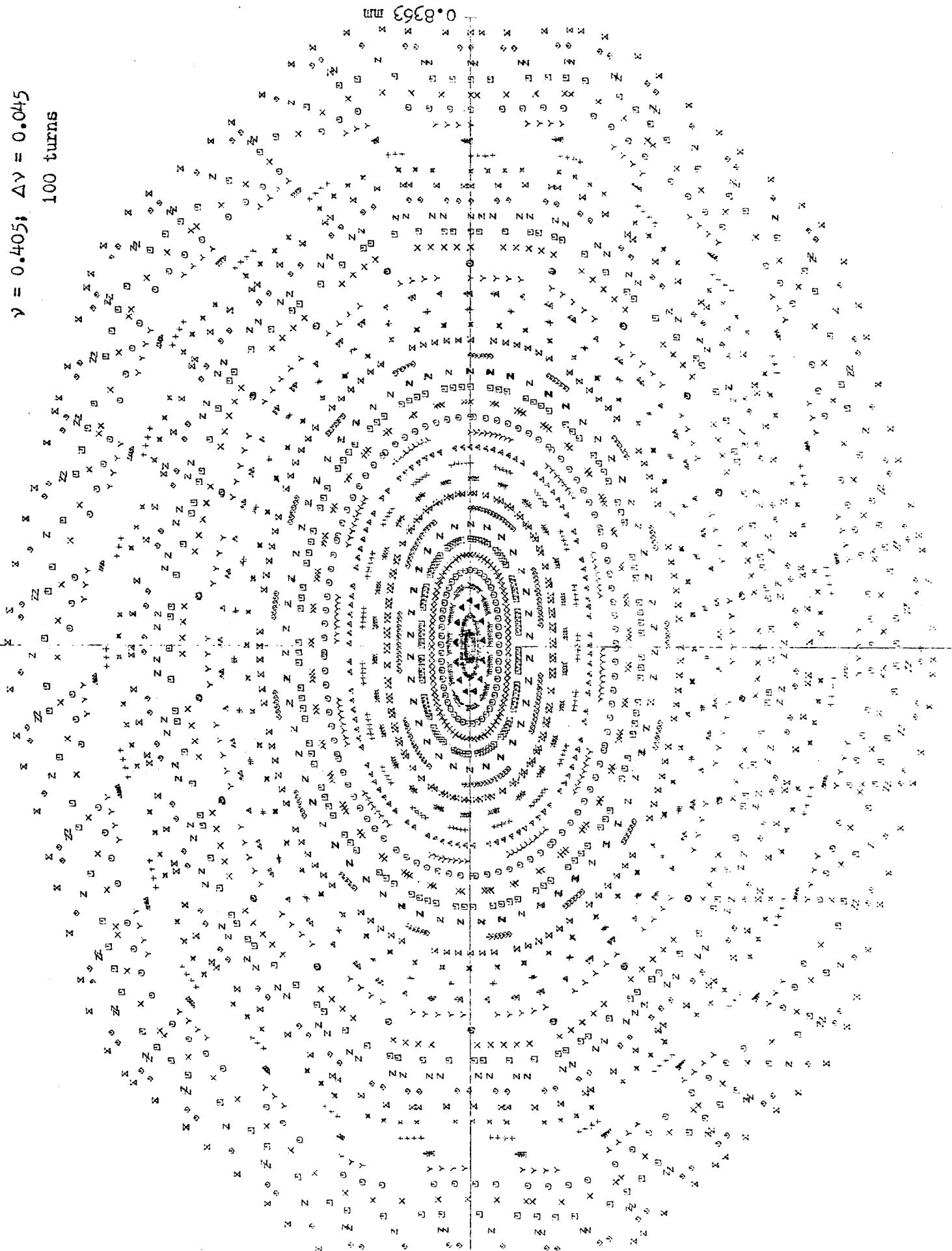


Figure 162 (λ, λ') Phase Plane

T = 1.117 mrad

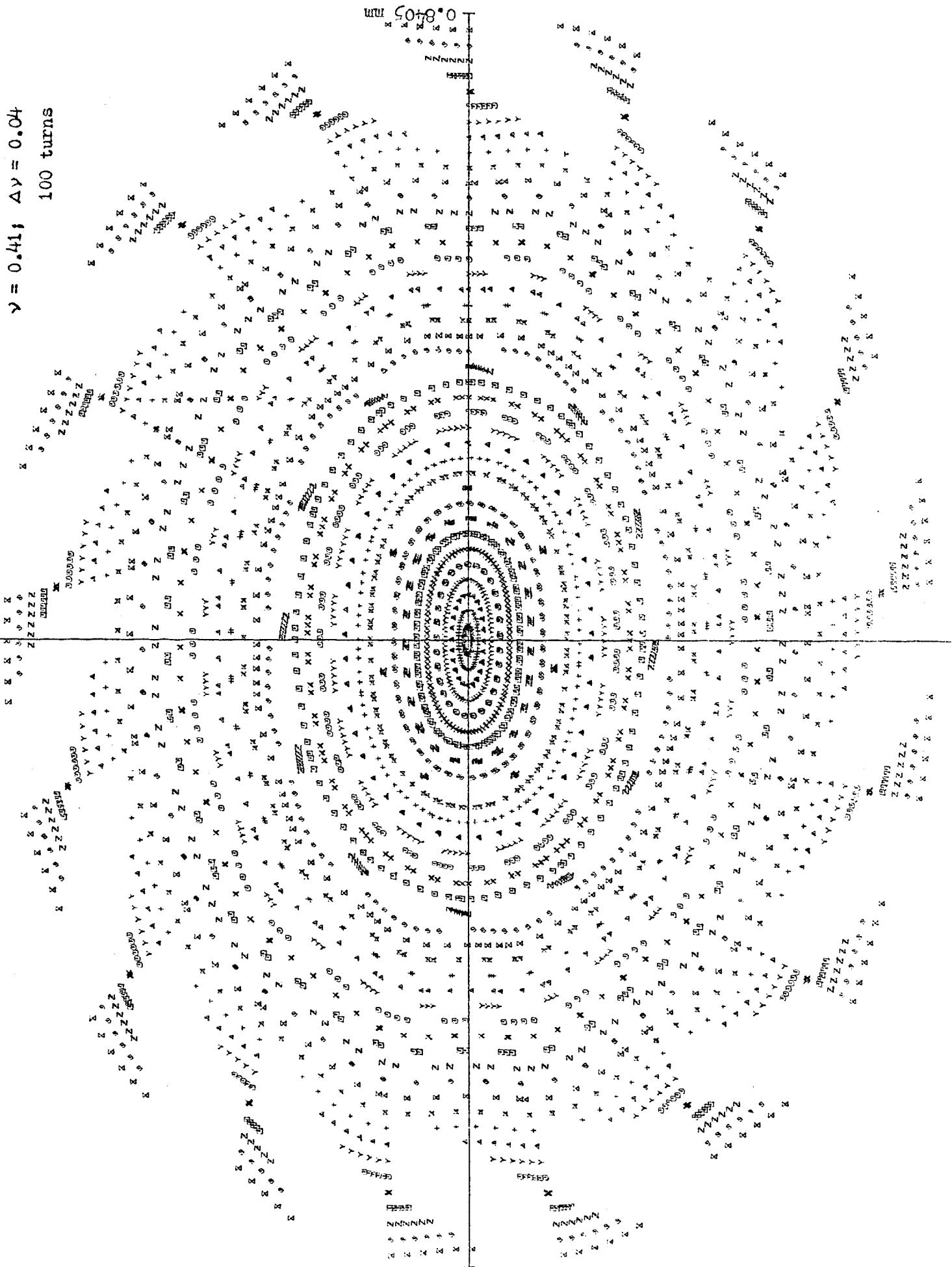
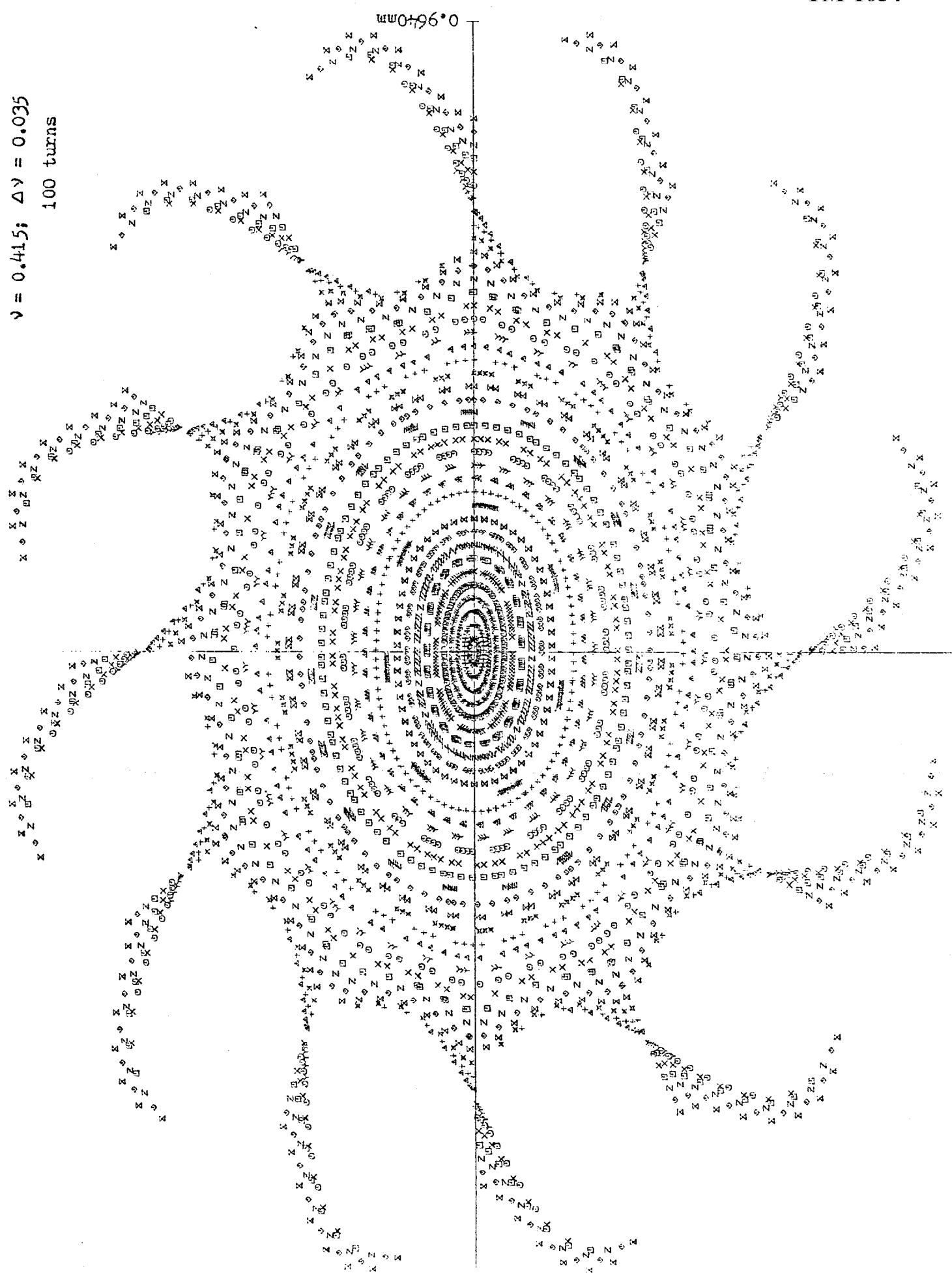
 $\gamma = 0.41; \Delta\gamma = 0.04$
 100 turns


Figure 163(X, X') Phase Plane

1.069 mrad

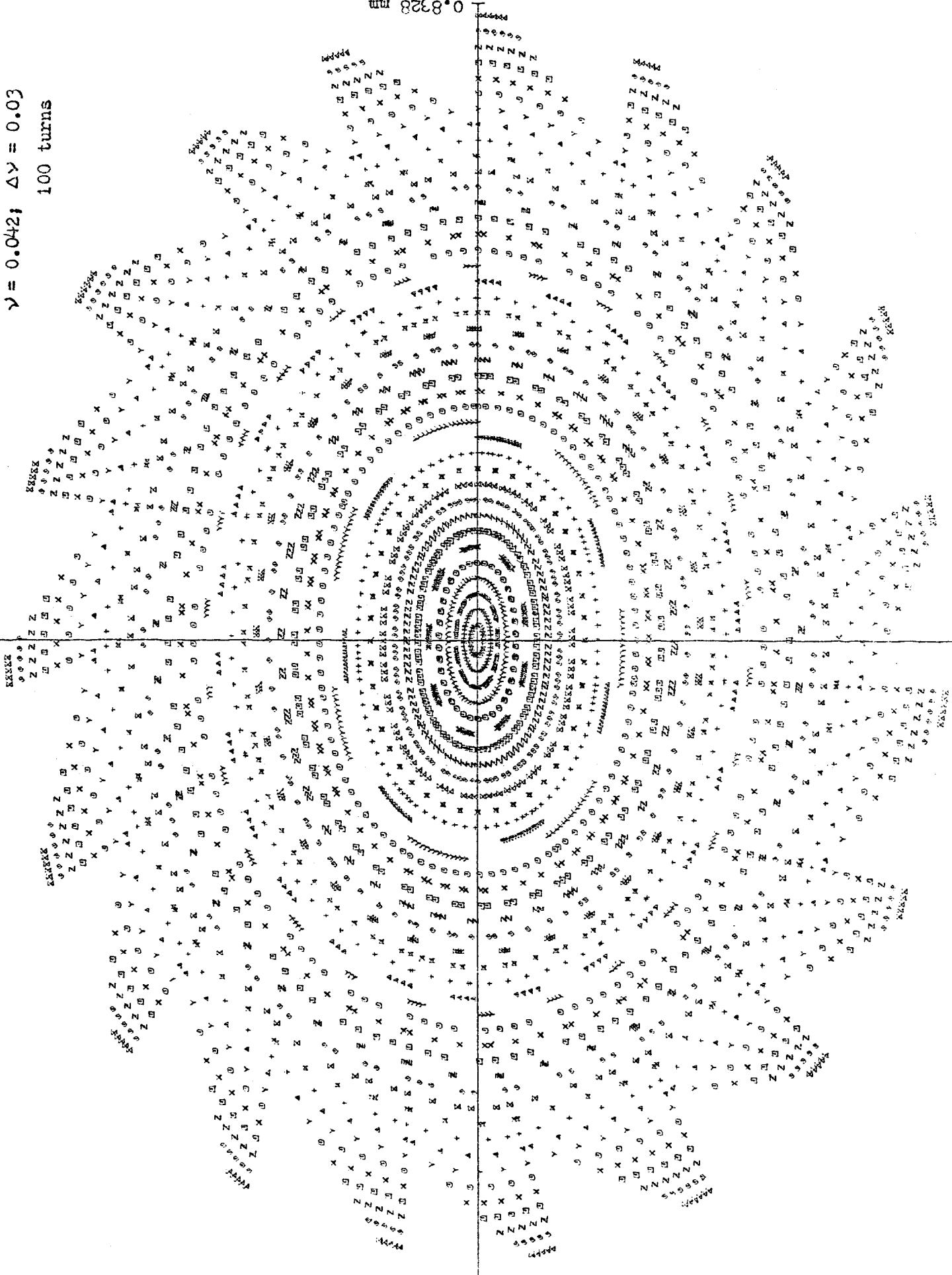


T 0.7906 mrad

Figure 164 (X, λ') Phase Plane

$\gamma = 0.042; \Delta\psi = 0.03$

100 turns



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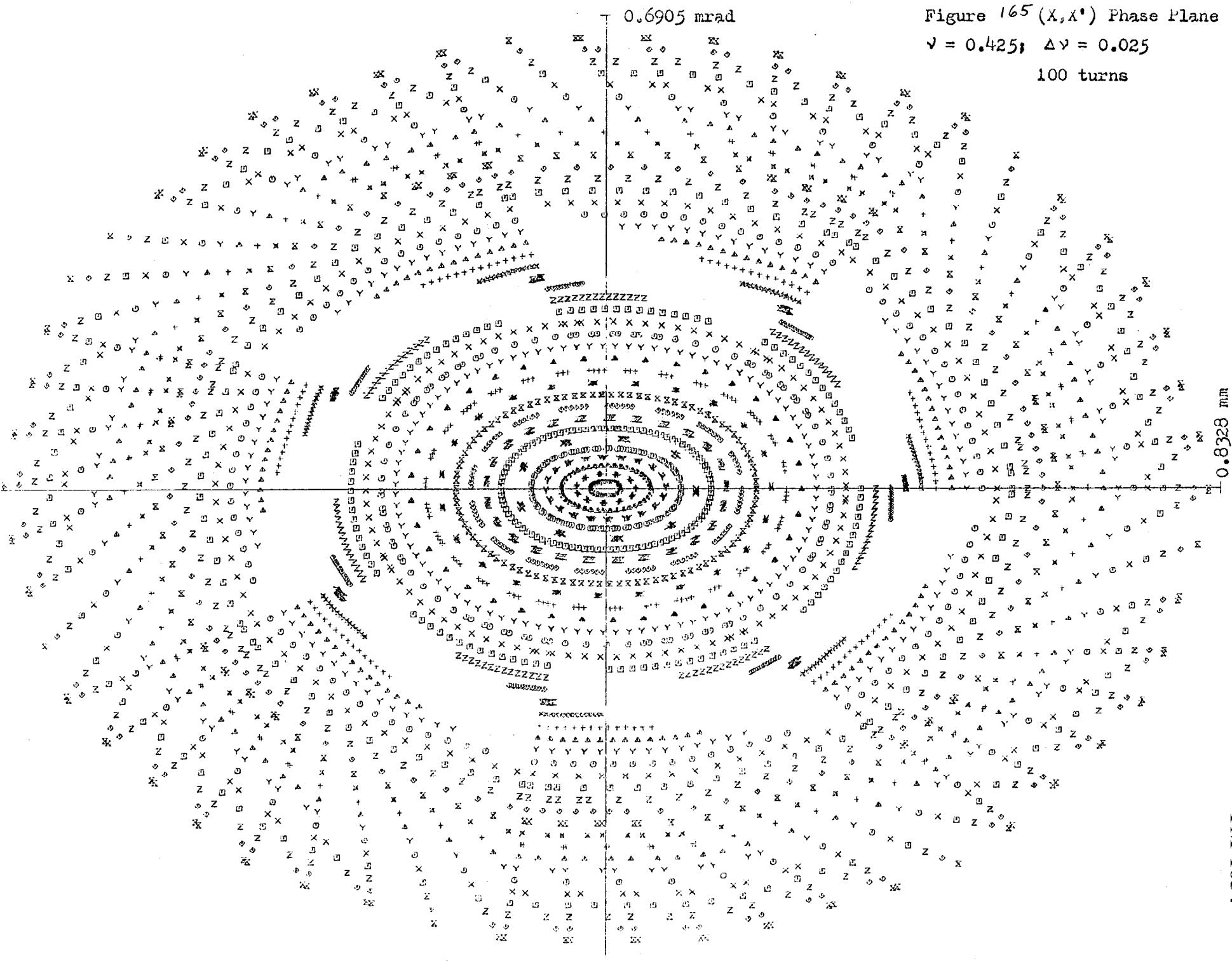


Figure 165
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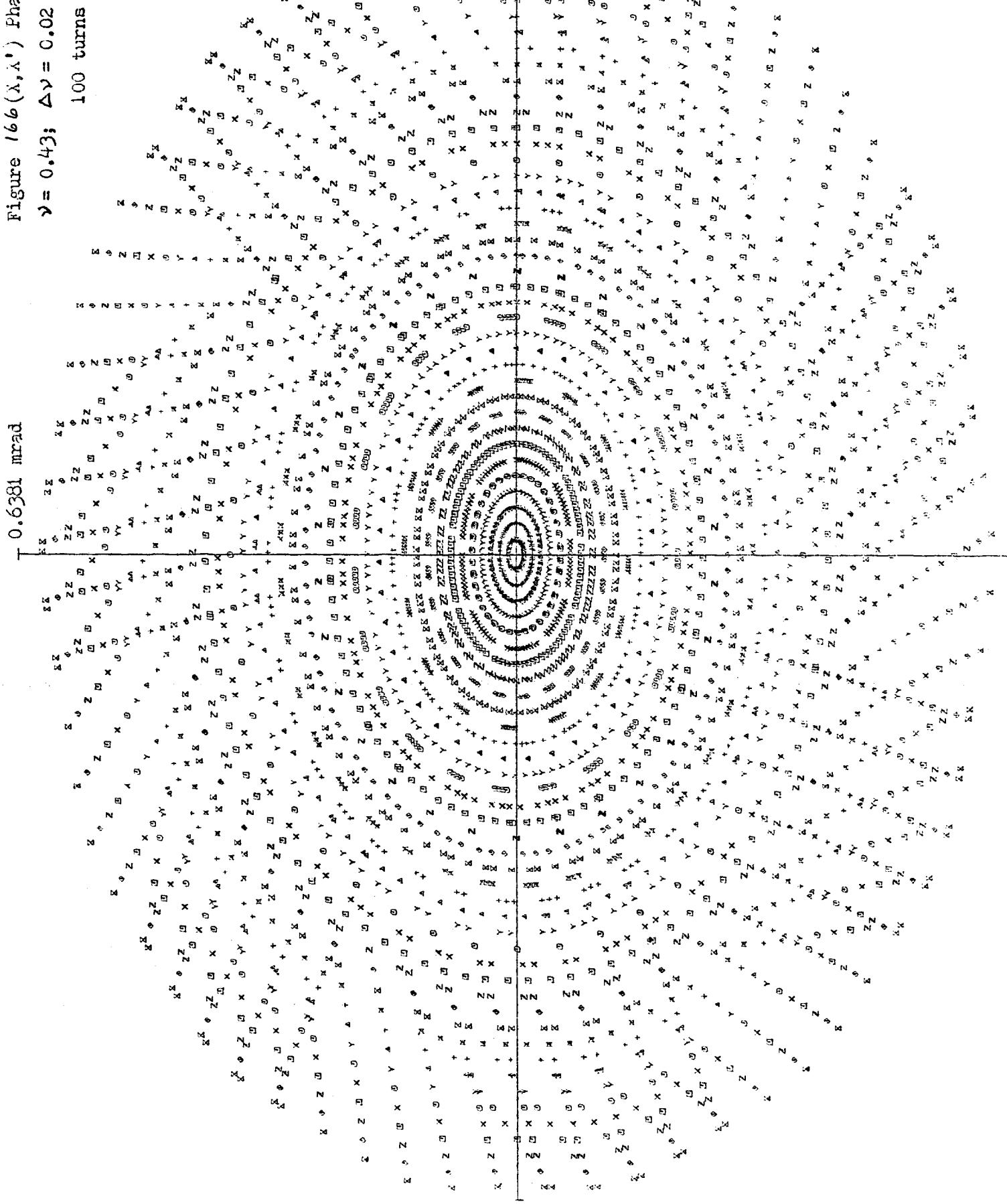
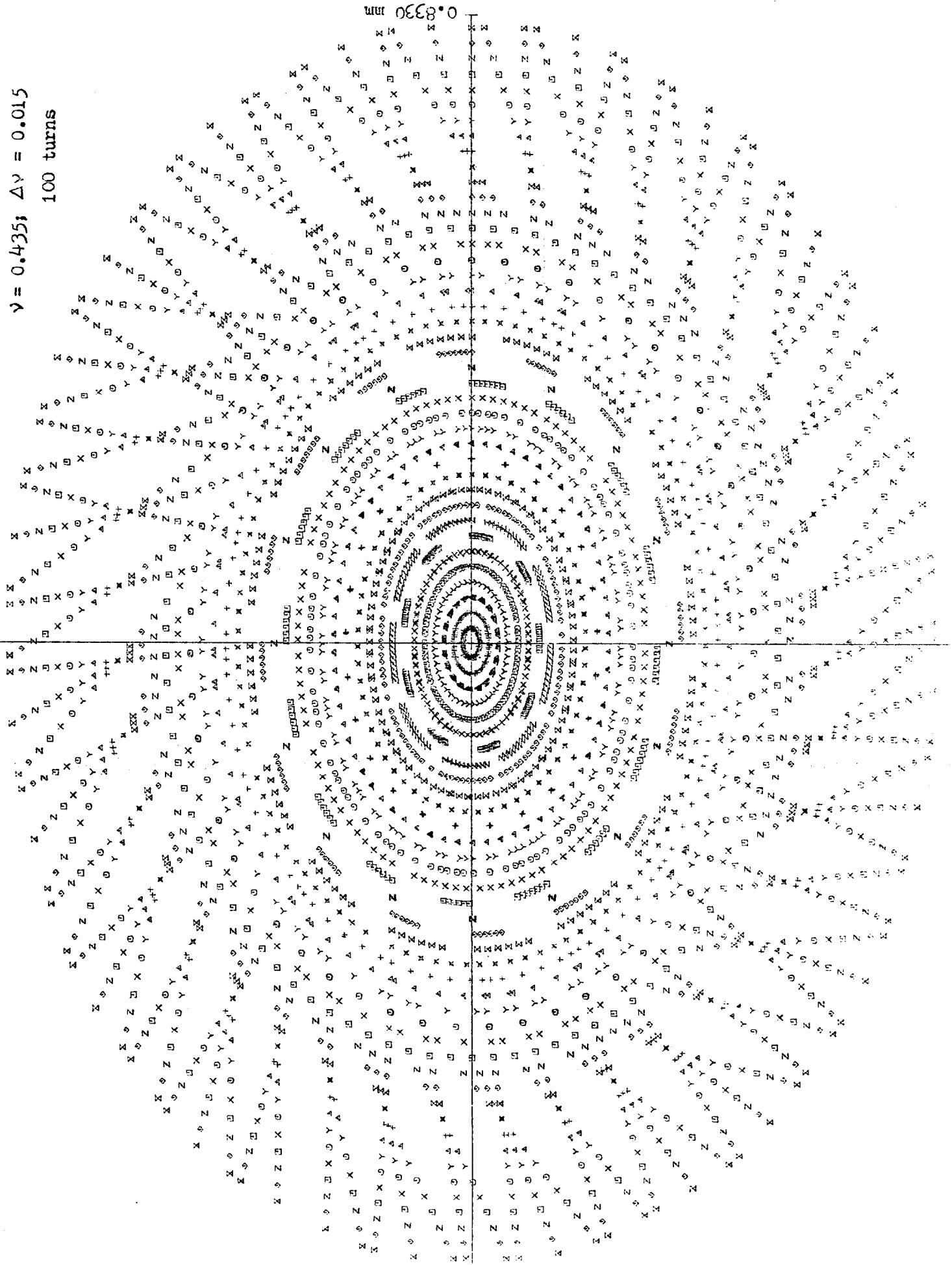
Figure 166(λ, λ') Phase Plane

Figure 167 (X, X') Phase Plane $\gamma = 0.435; \Delta\psi = 0.015$

100 turns

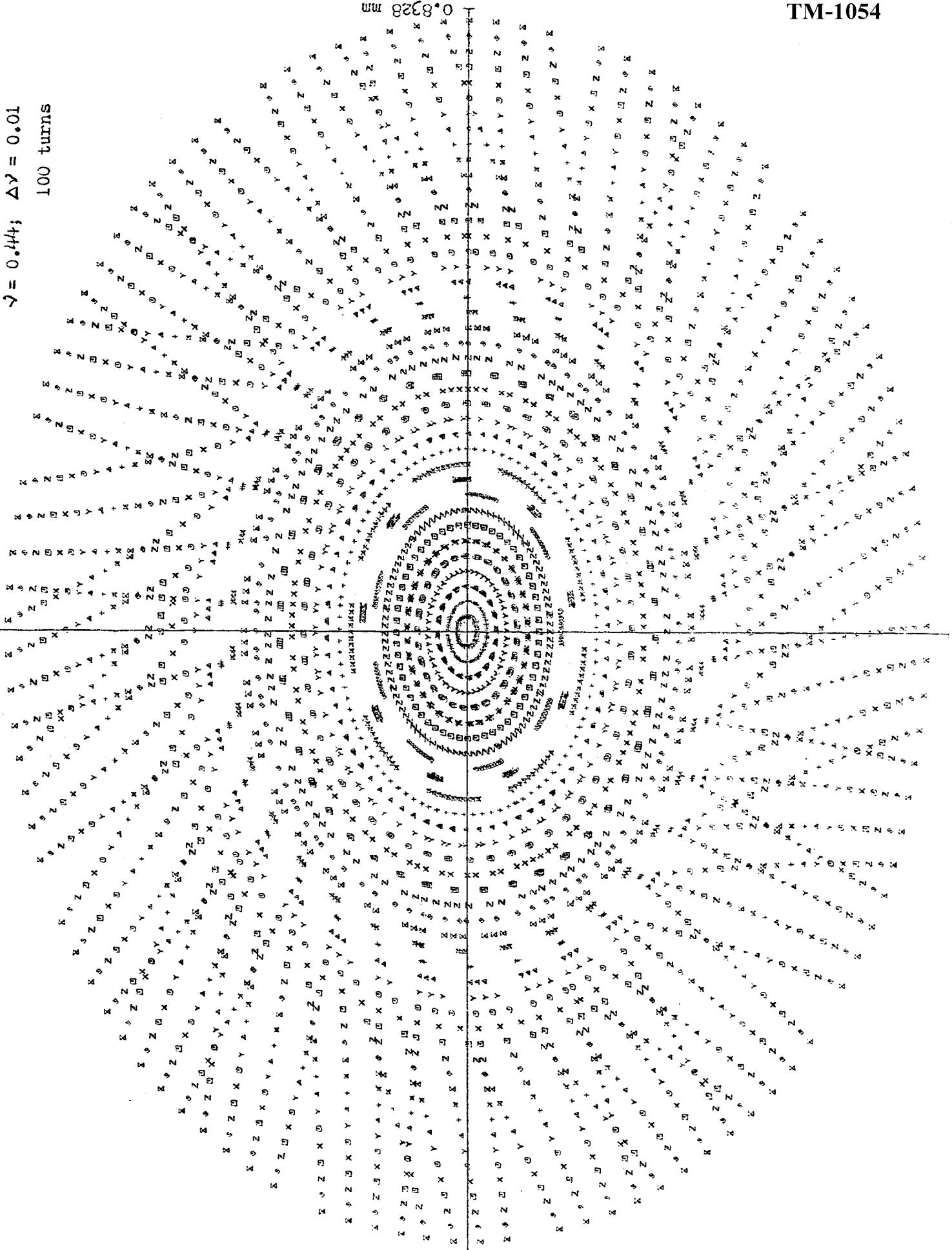
T 0.5681 mrad.



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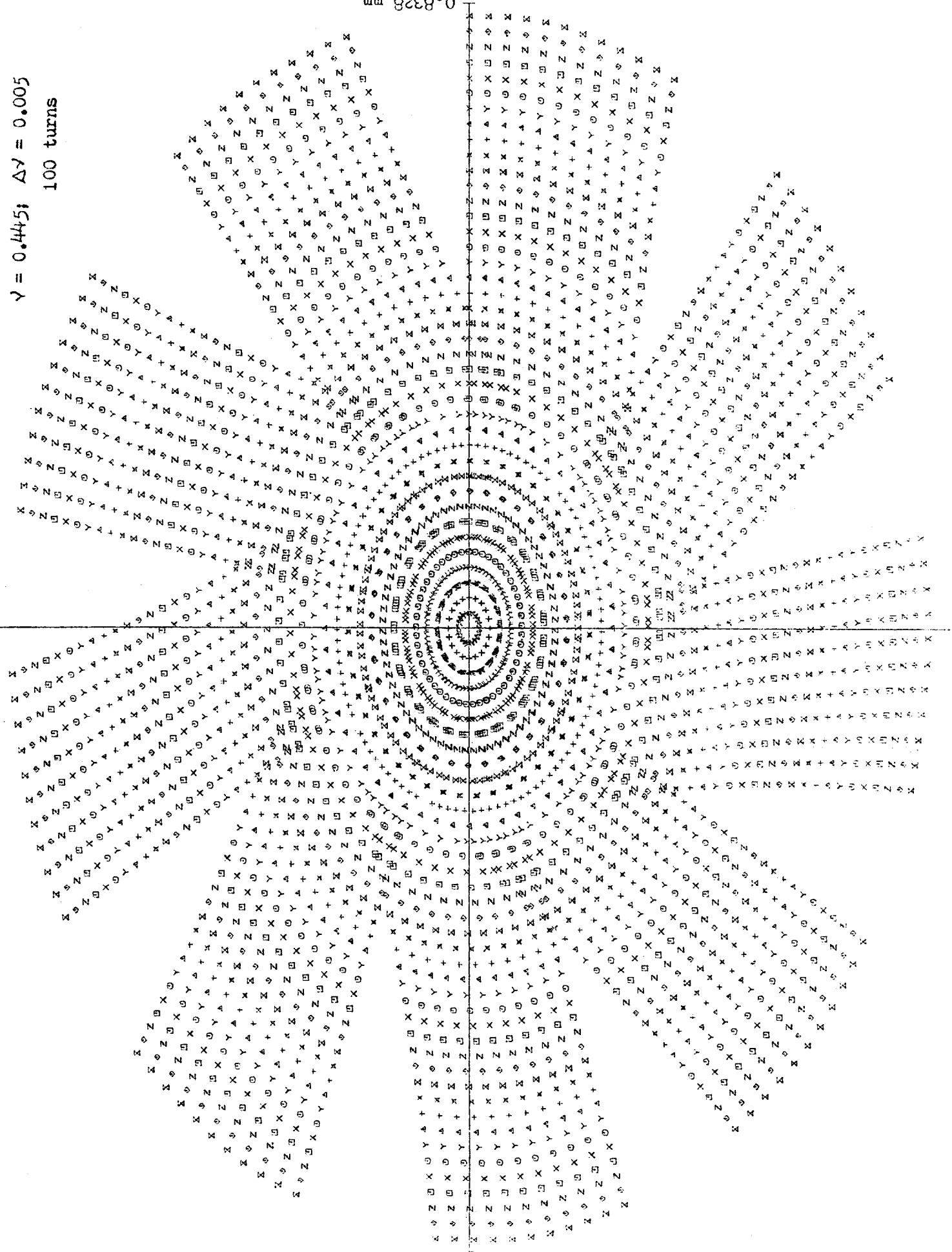
Figure 168 (X, X') Phase Plane $T = 0.5141 \text{ mrad}$ $\gamma = 0.444; \Delta\gamma = 0.01$

100 turns



$\Gamma = 0.4711 \text{ mrad}$ Figure 169 (X, X') Phase Plane $\gamma = 0.445; \Delta\gamma = 0.005$

100 turns



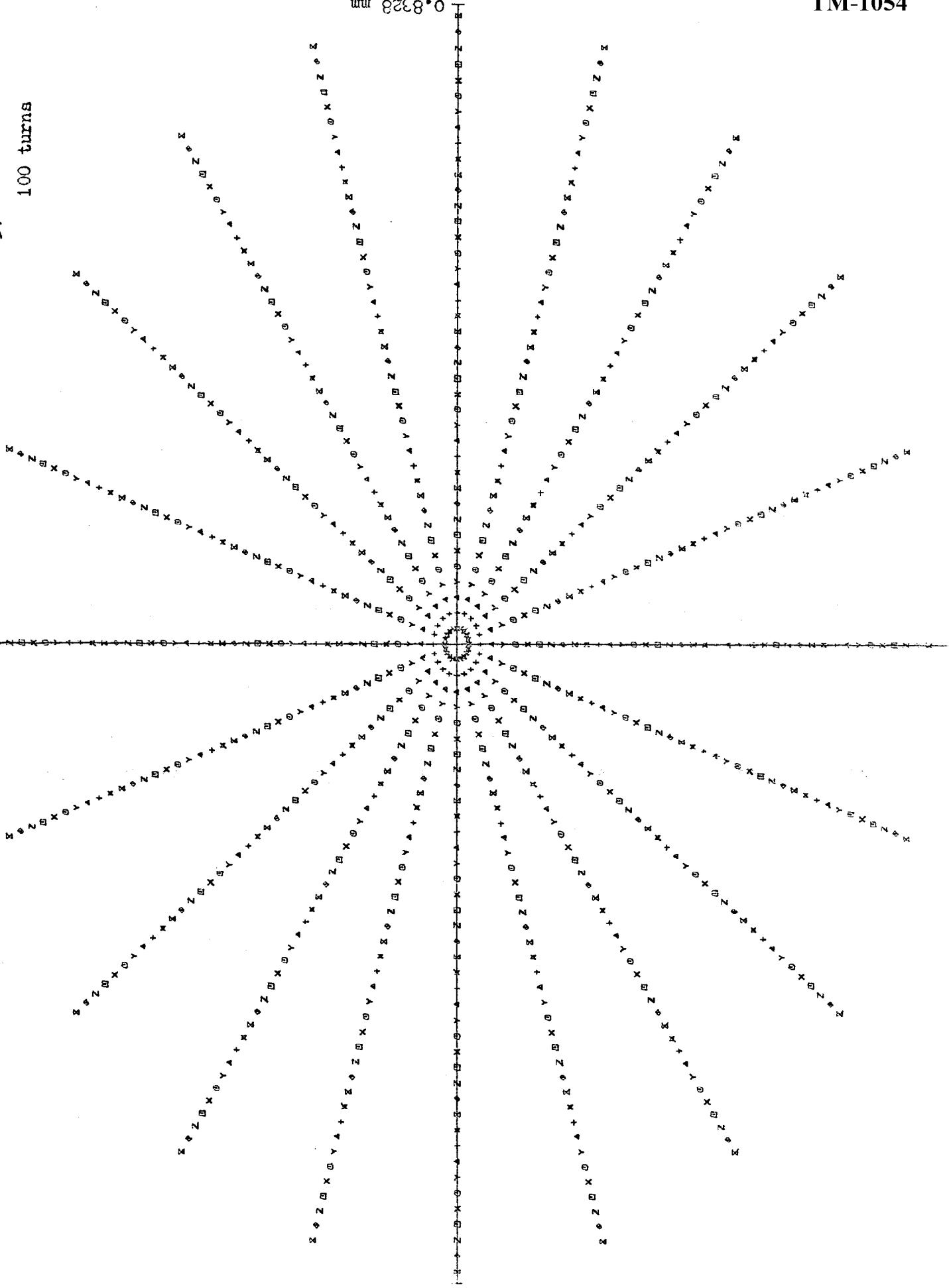
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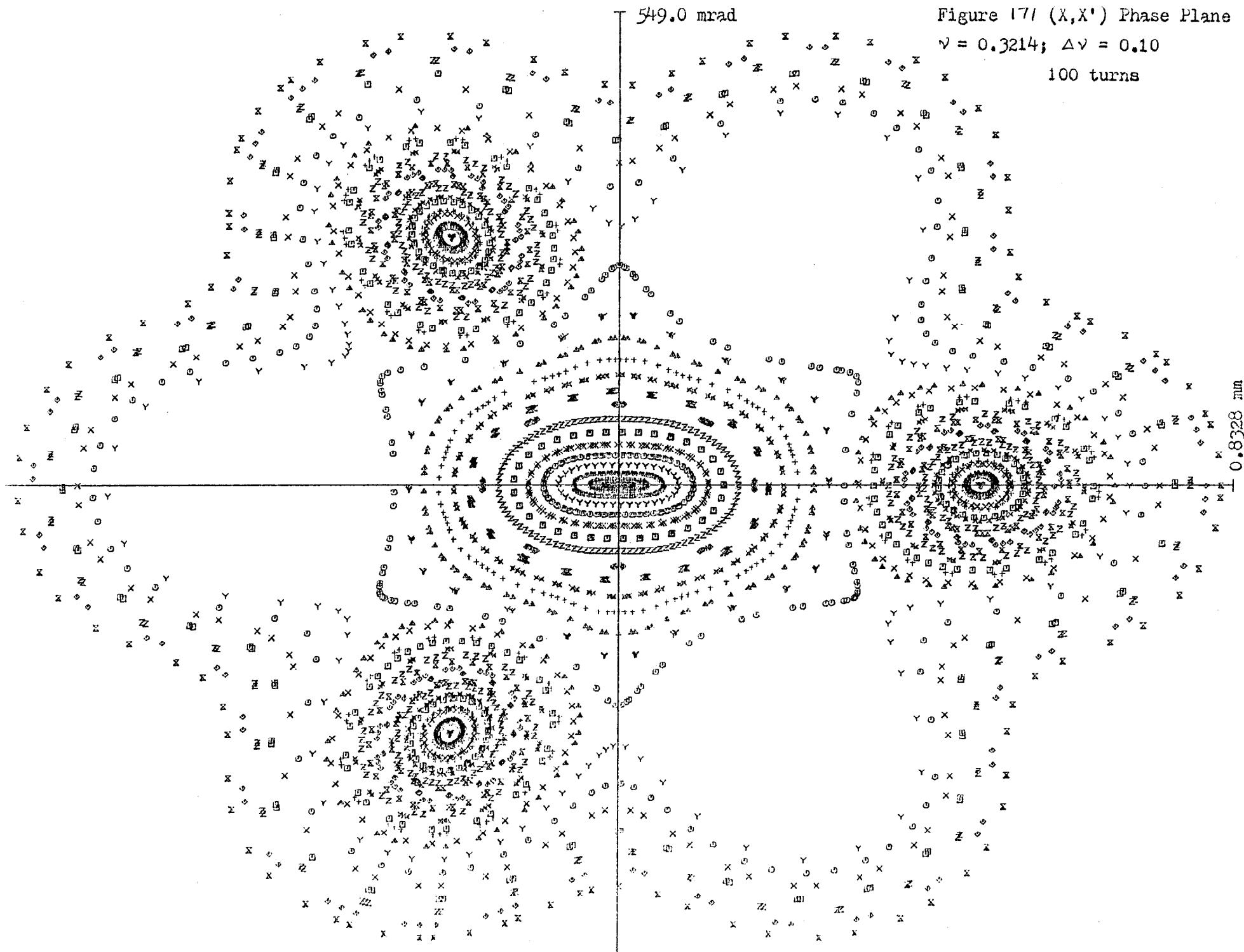
Figure 17D(X, X') Phase Plane $\gamma = 0.45; \Delta v = 0$

100 turns

T 0.4287 mrad

0.8328 mm





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773.2 mrad

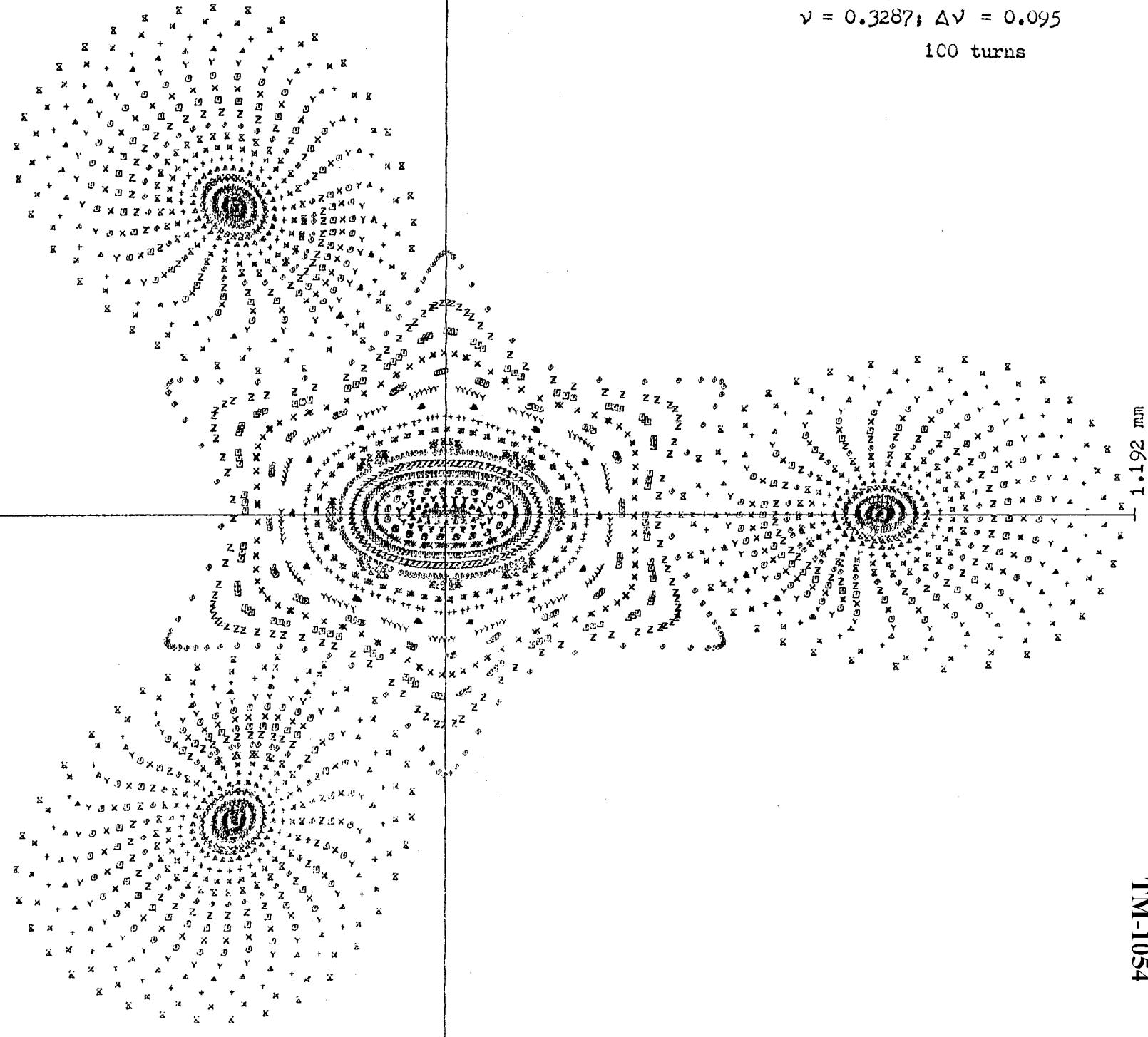


Figure 172 (X, X') Phase Plane
 $\nu = 0.3287; \Delta\nu = 0.095$
100 turns

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21271 172

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Figure 173 (X, X') Phase Plane $\nu = 0.3362; \Delta\nu = 0.09$

100 turns

T 717.8 mrad

III 98.6° 0

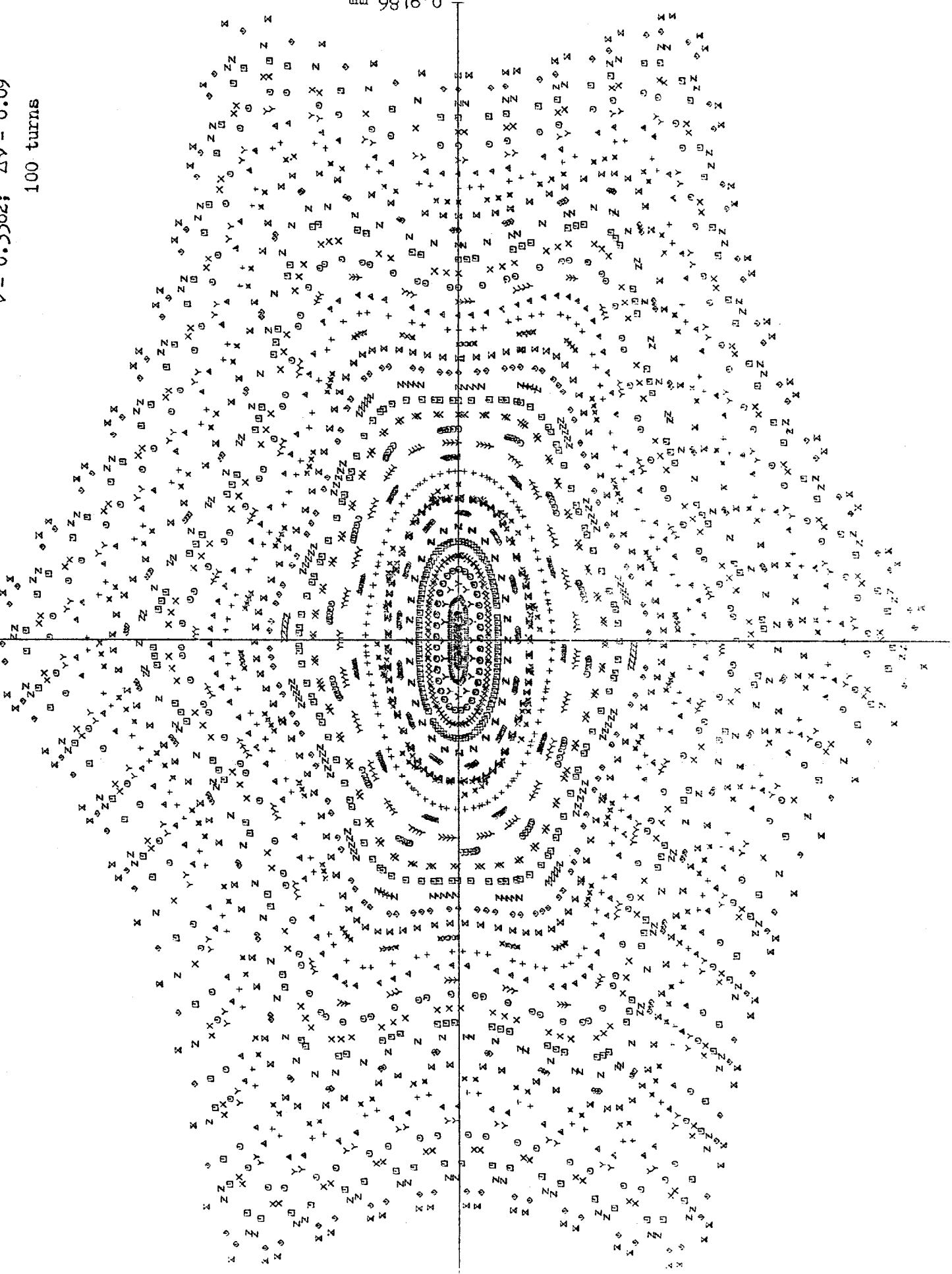
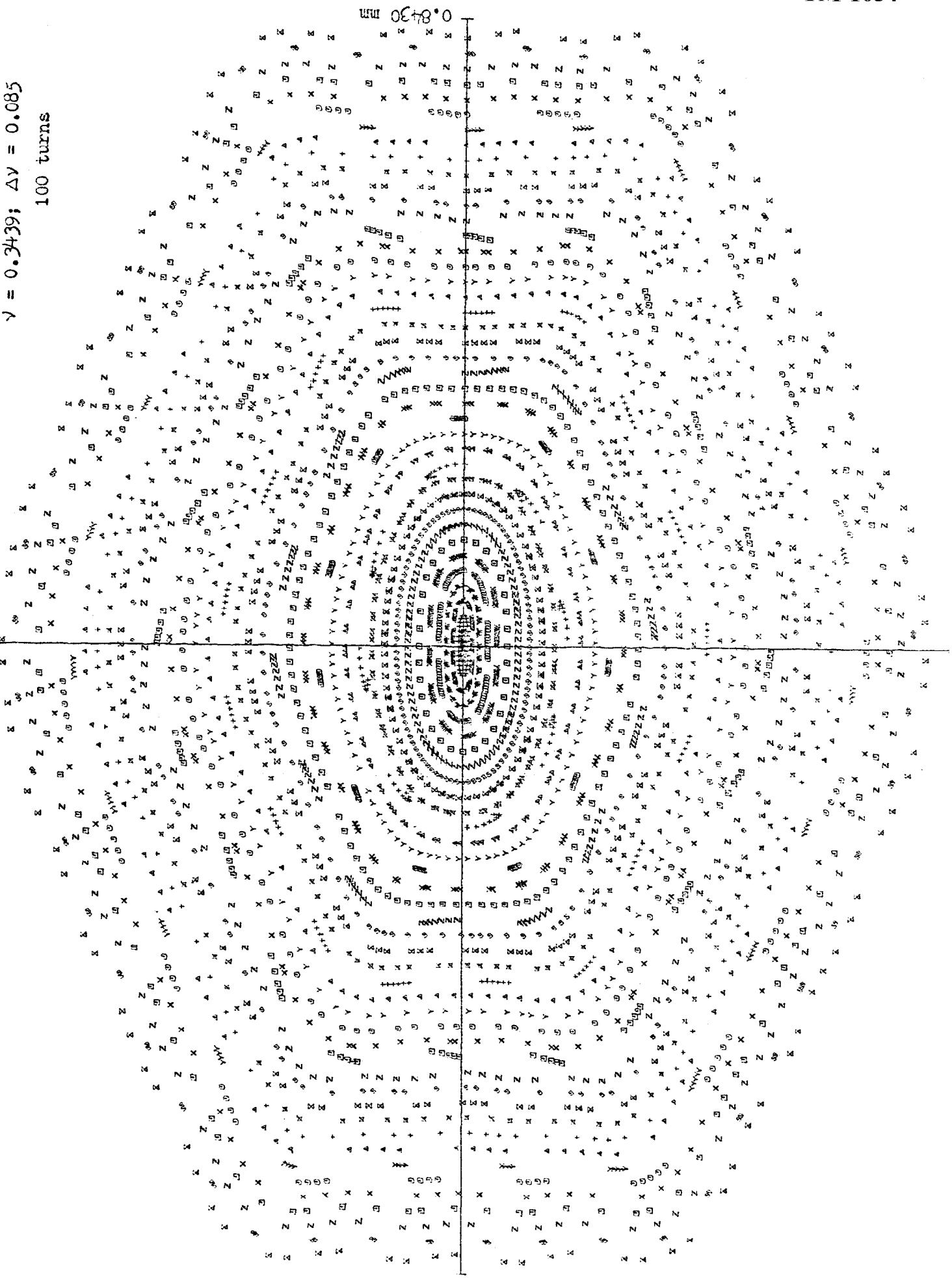


Figure 174 (X, X') Phase plane $\gamma = 0.3439; \Delta\gamma = 0.085$

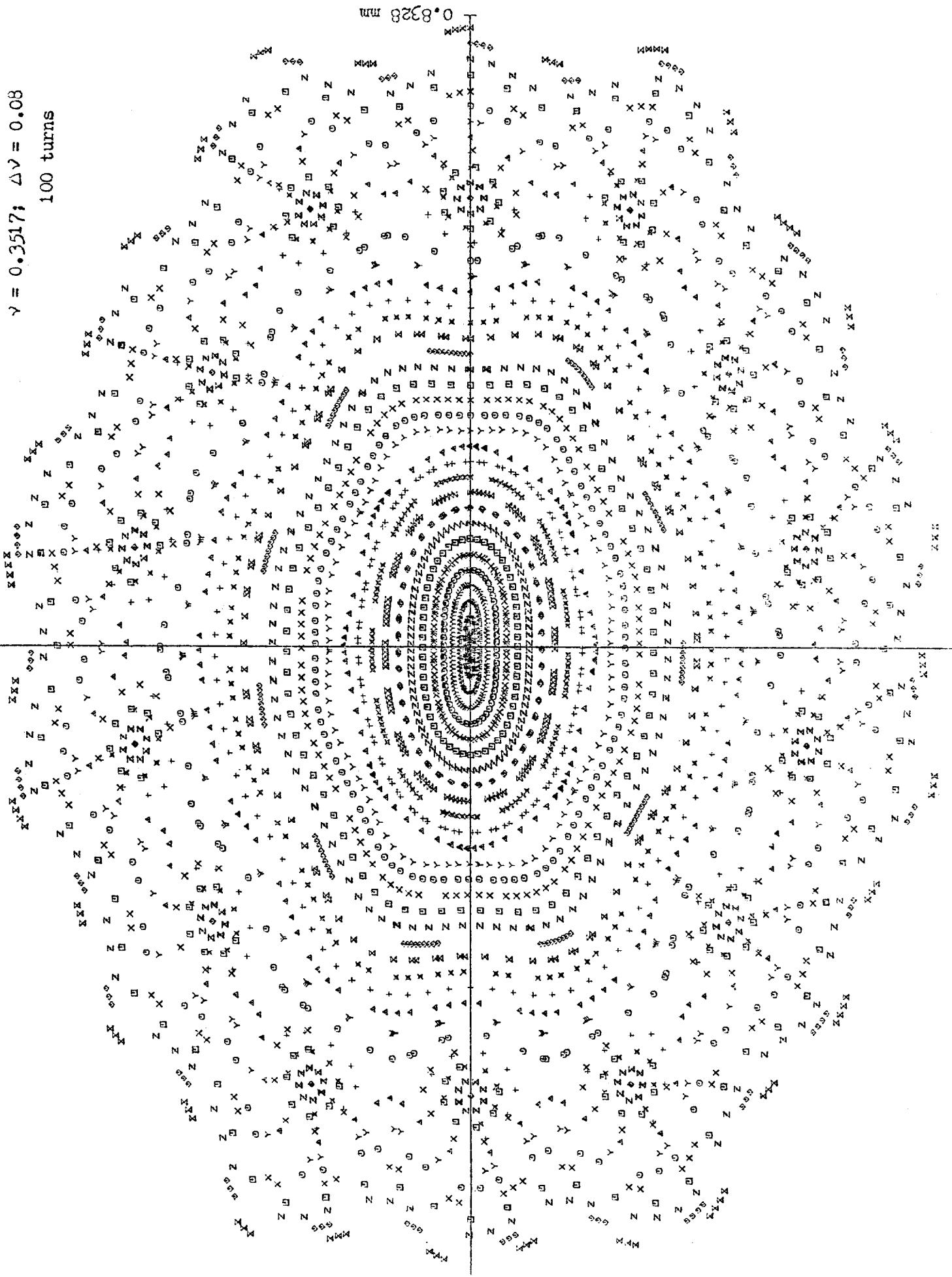
100 turns

T 604.9 mrad

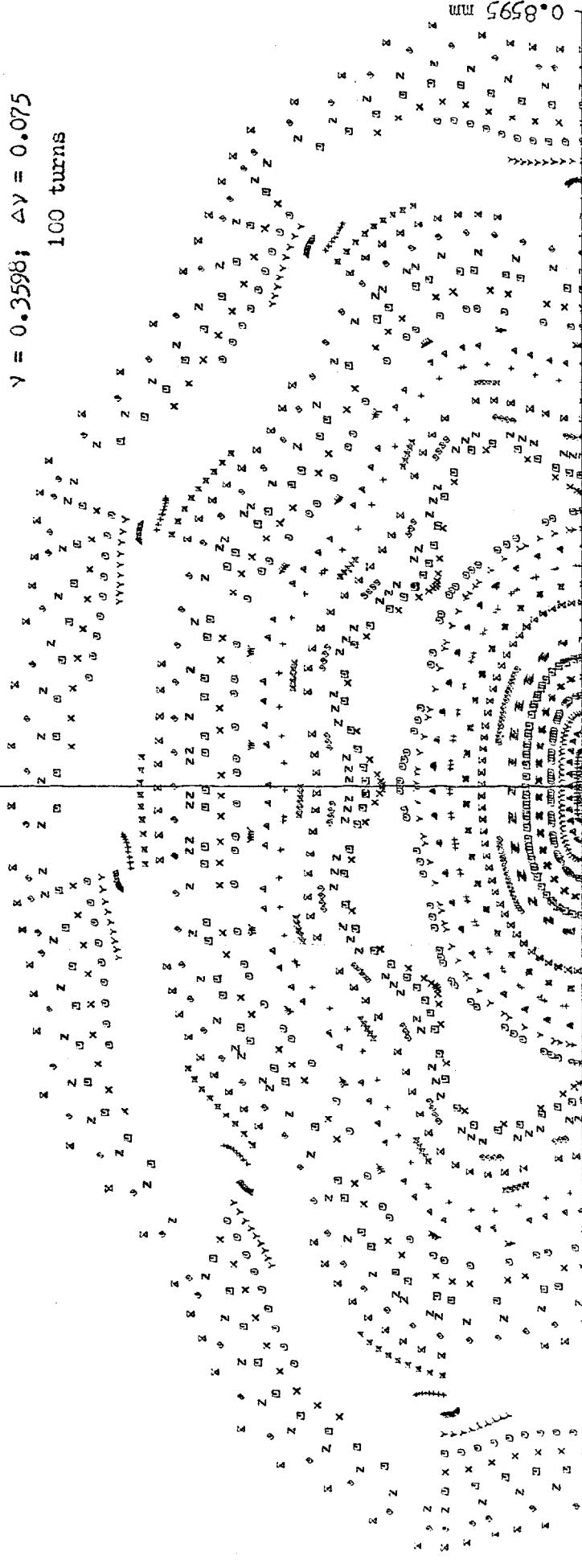


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Figure 175(X,X') Phase Plane

 $T = 543.5 \text{ mrad}$ 

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Figure 176(X, X') Phase Plane $T = 535.2 \text{ mrad}$
 $\gamma = 0.3598; \Delta\gamma = 0.075$
 100 turns


MM 5658.0

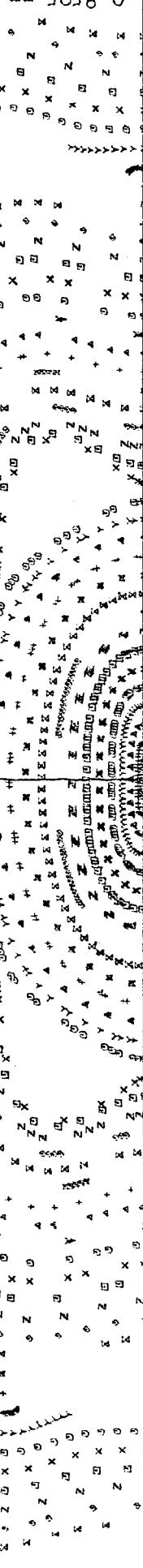
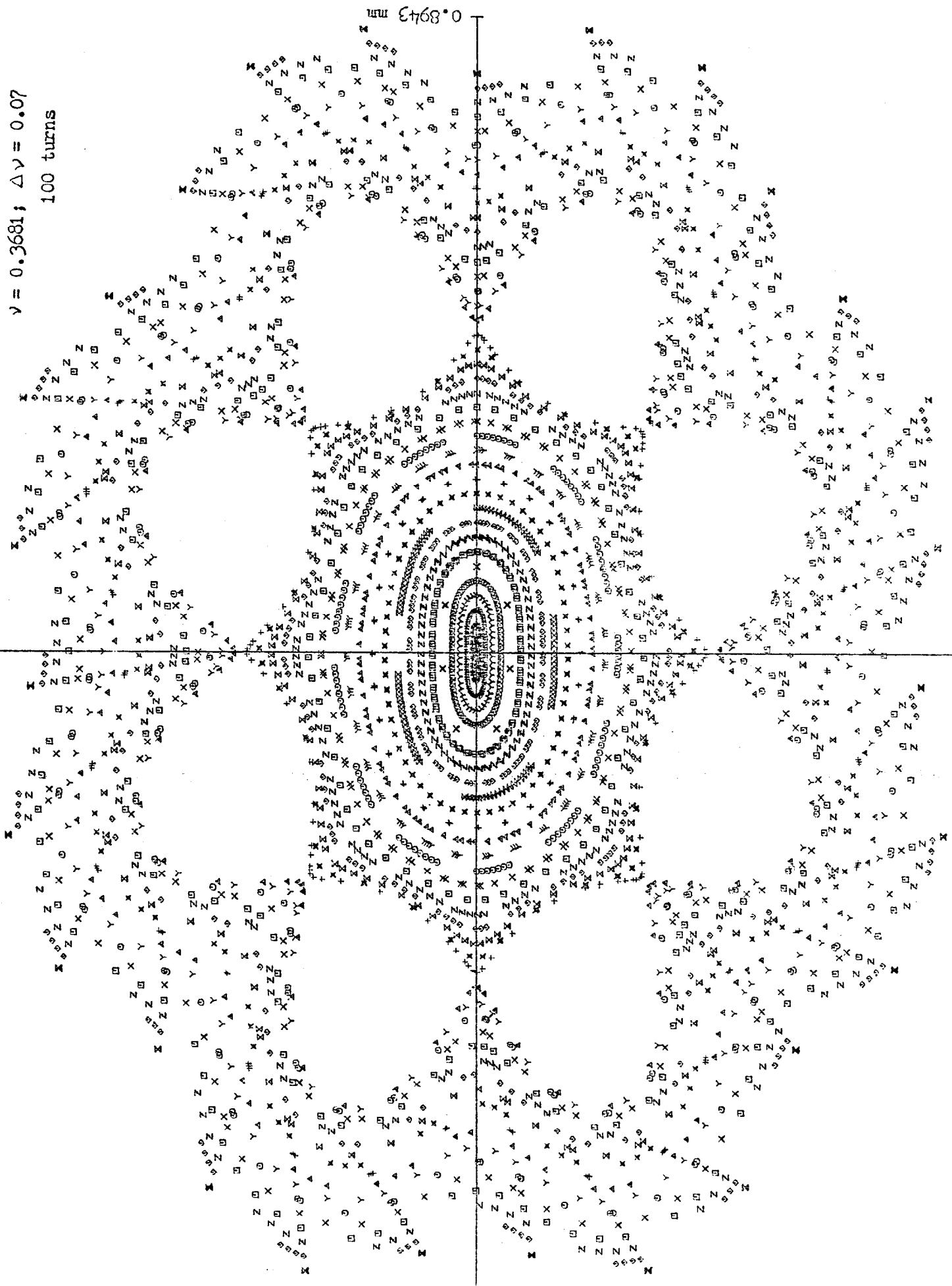


Figure 177 (X, X') Phase Plane

$T = 530.1 \text{ mrad}$

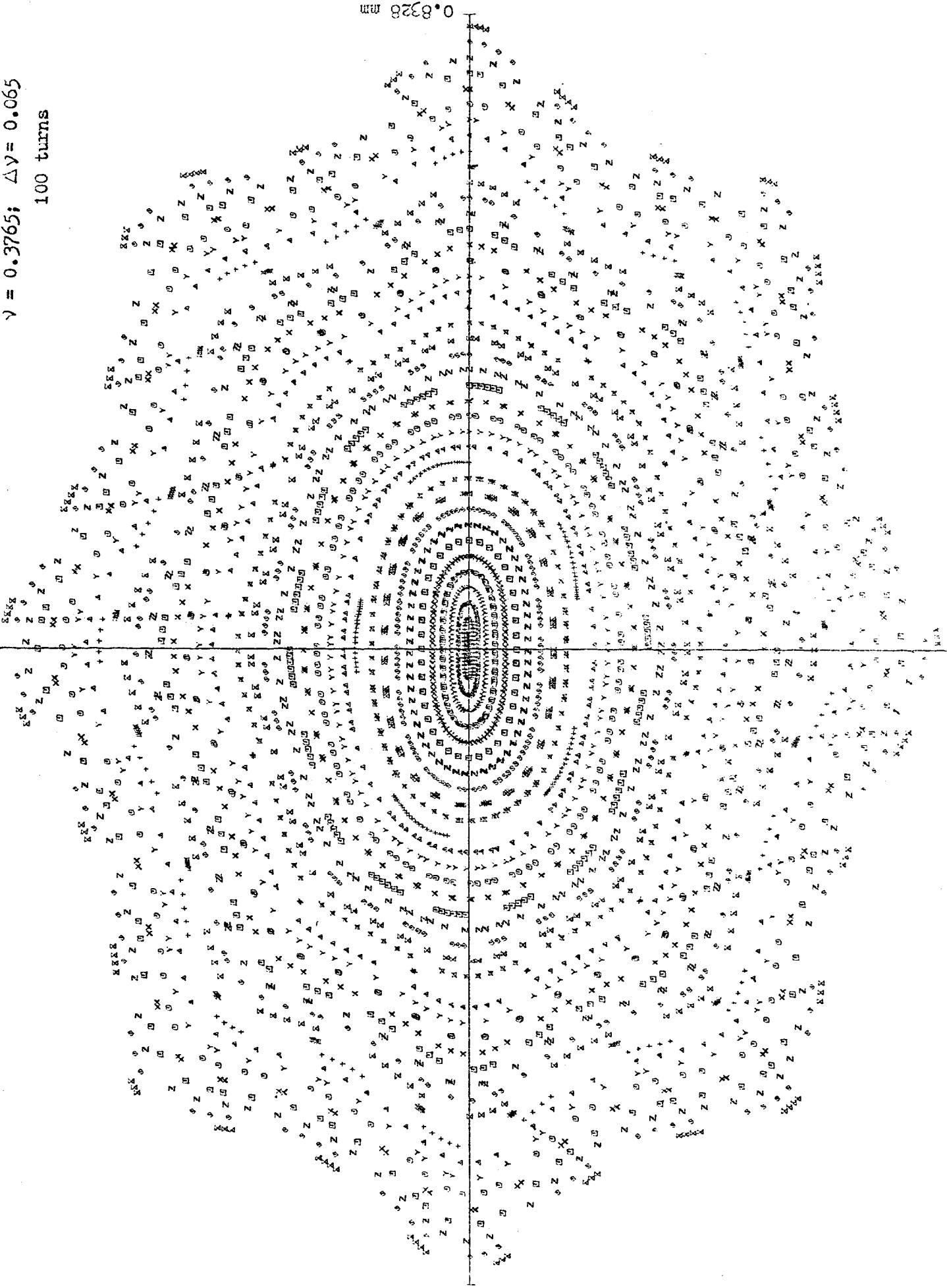


T 465.1 mrad

Figure 178 (X, λ') Phase Plane

$$\gamma = 0.3765; \Delta\gamma = 0.065$$

100 turns



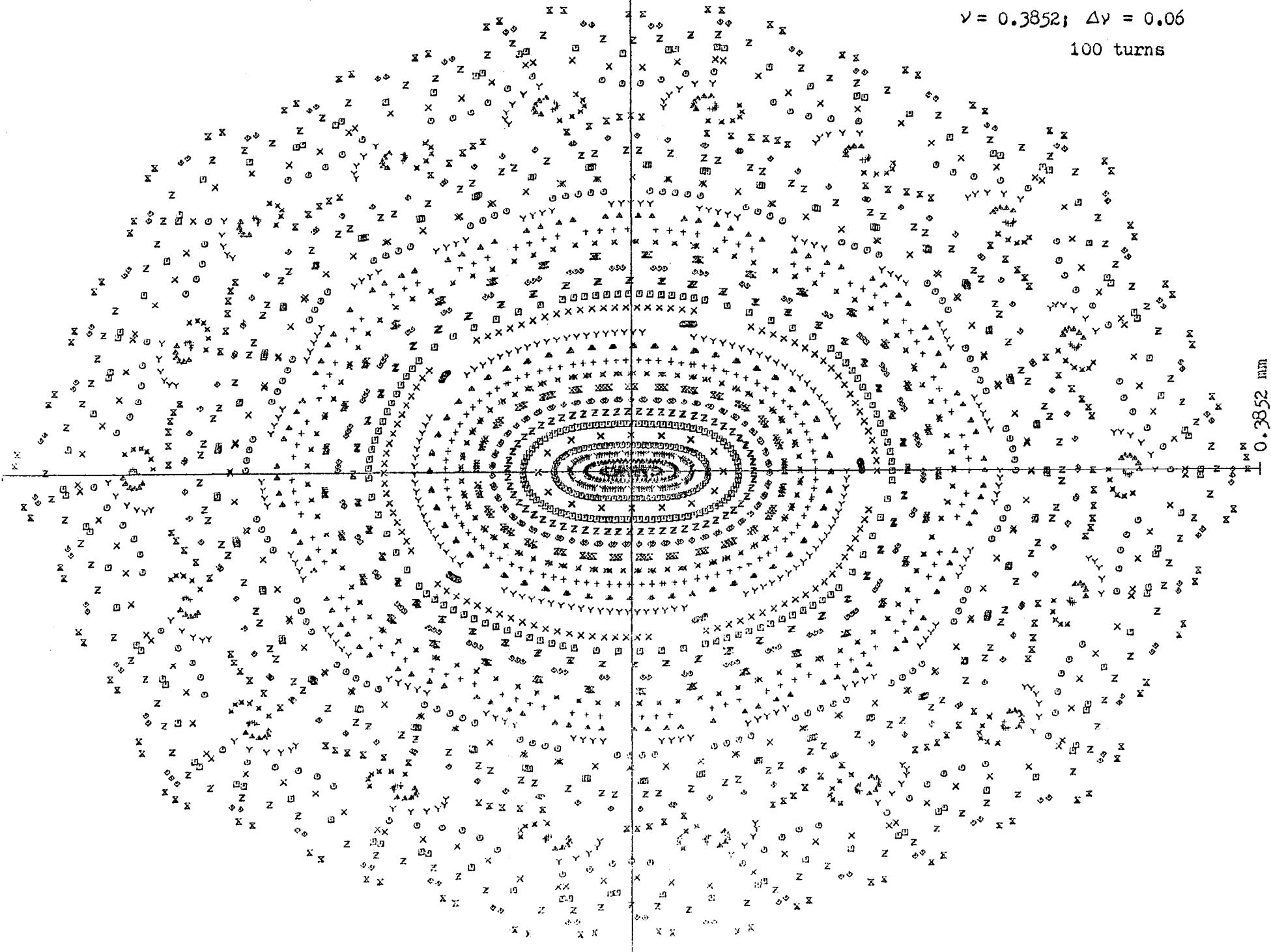
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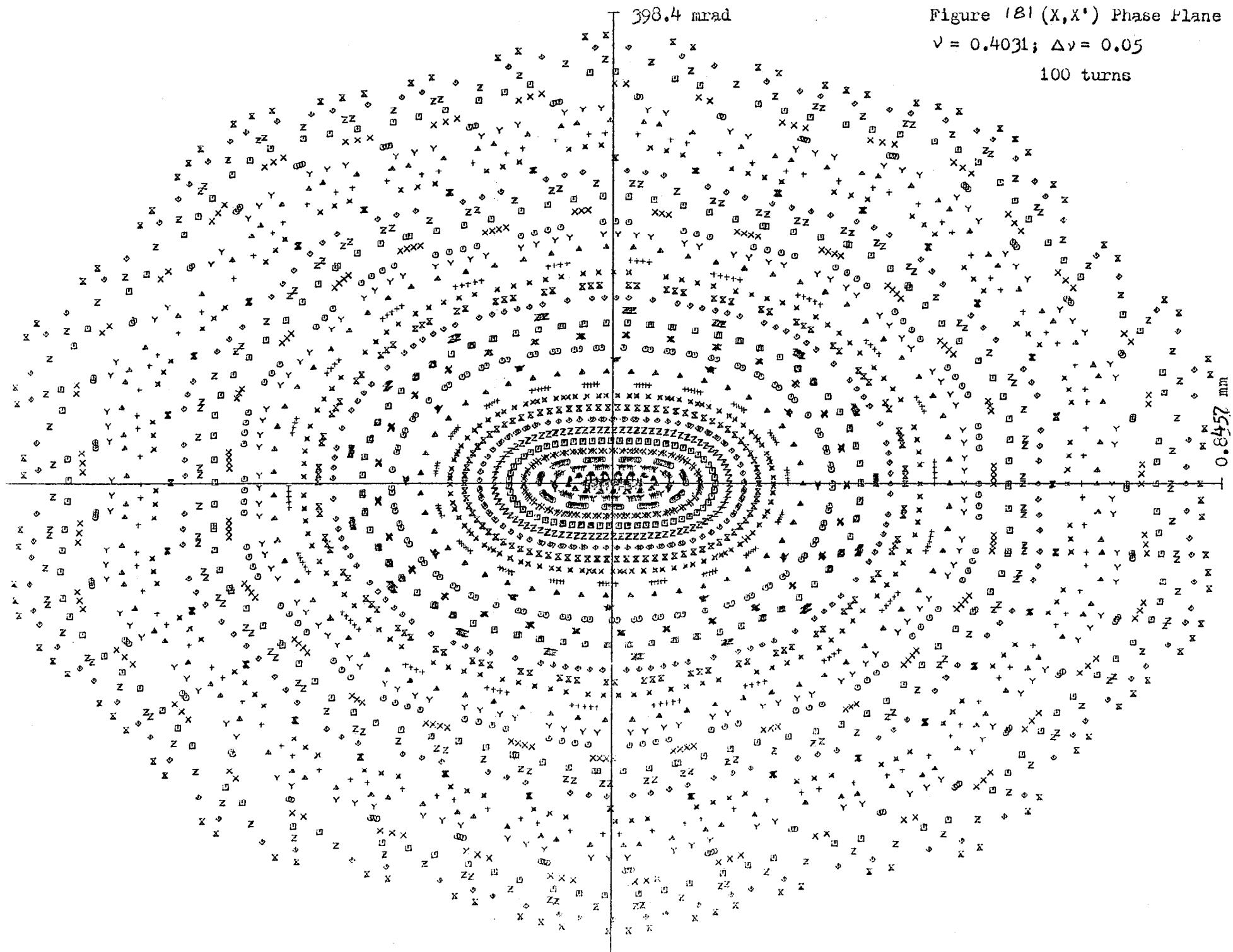
T 425.0 mrad

Figure 179 (x, x') Phase Plane

$\nu = 0.3852$; $\Delta\nu = 0.06$

100 turns



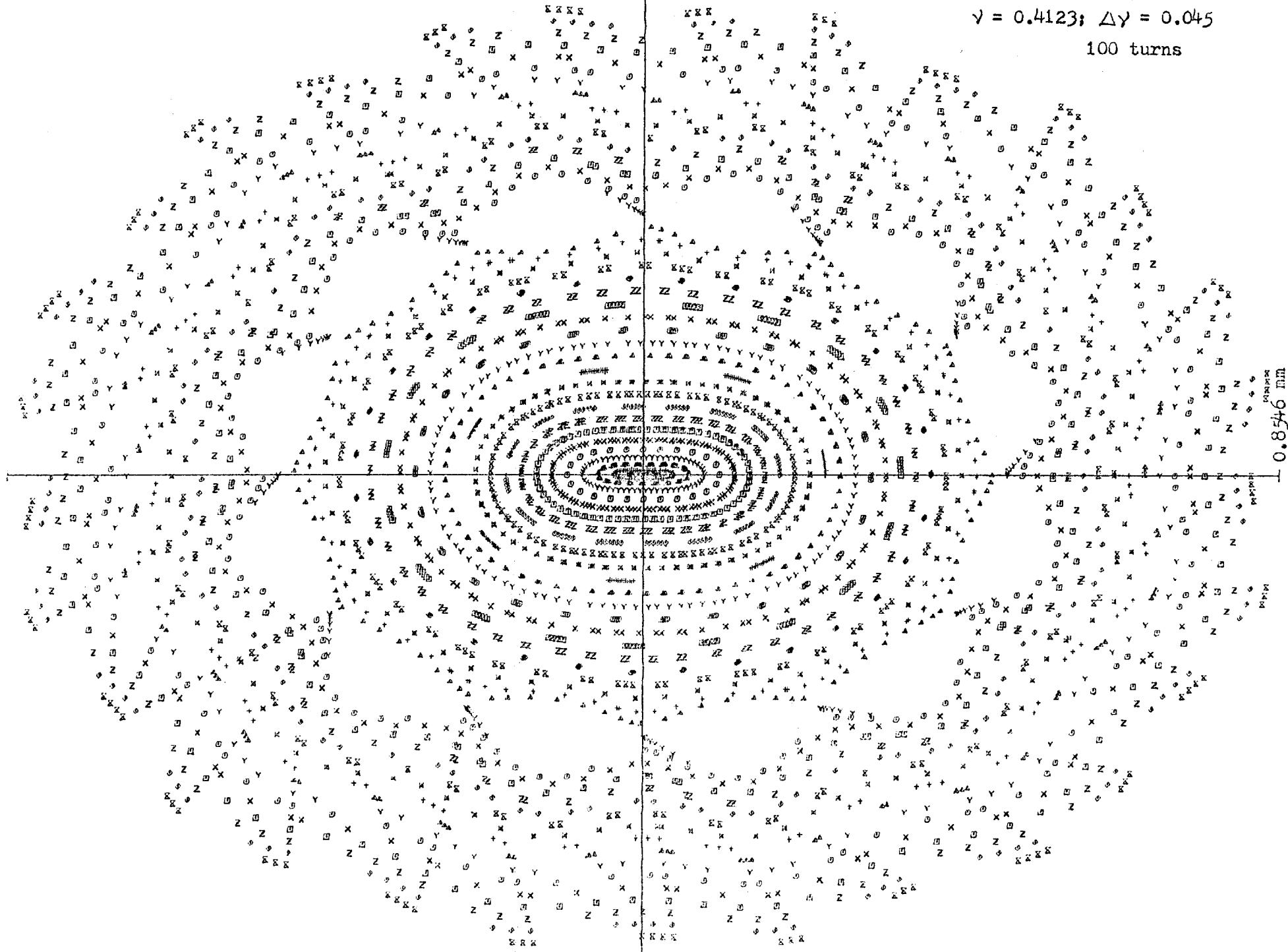


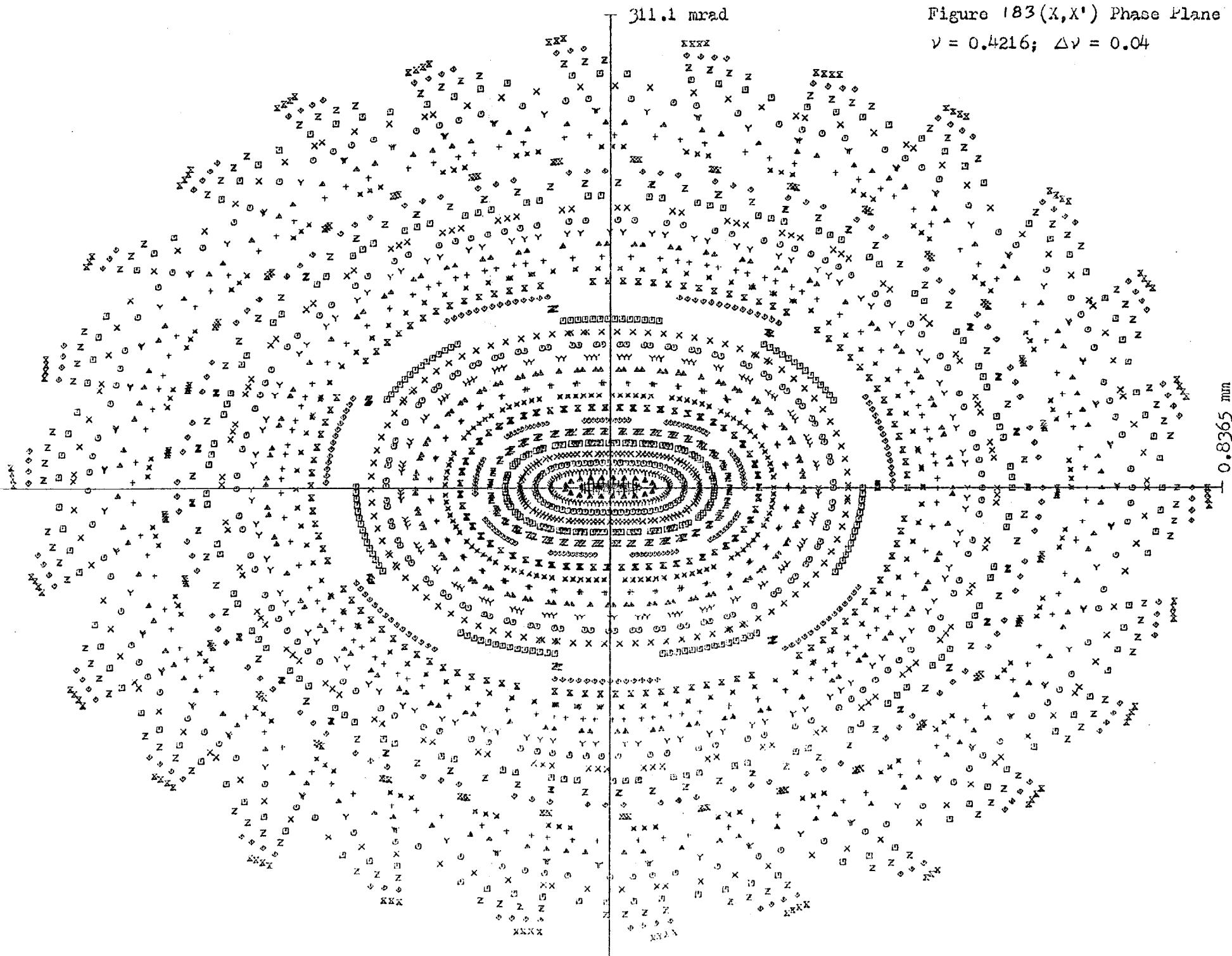
356.0 mrad

Figure 182(X, X') Phase Plane

$\gamma = 0.4123; \Delta\gamma = 0.045$

100 turns

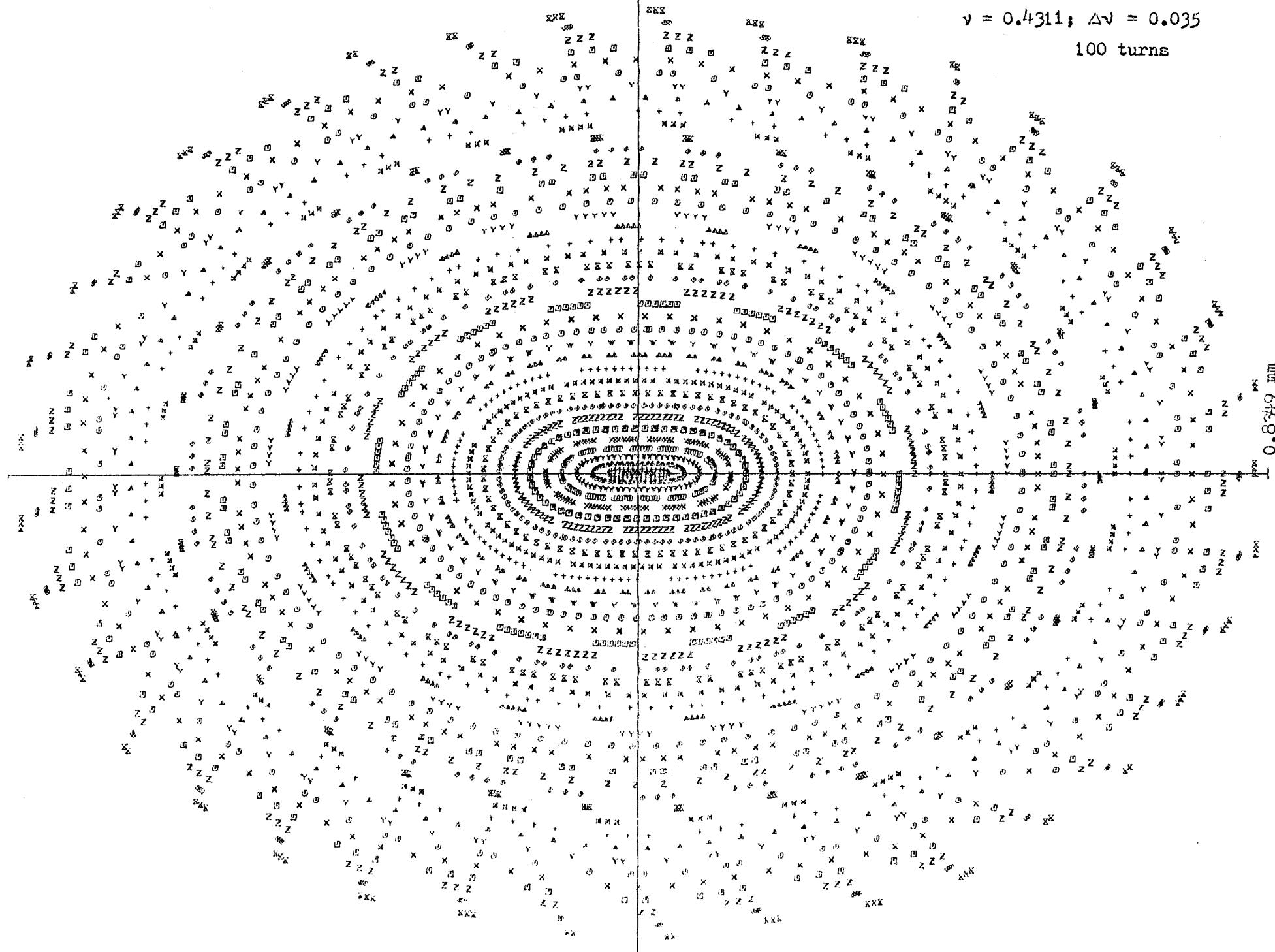


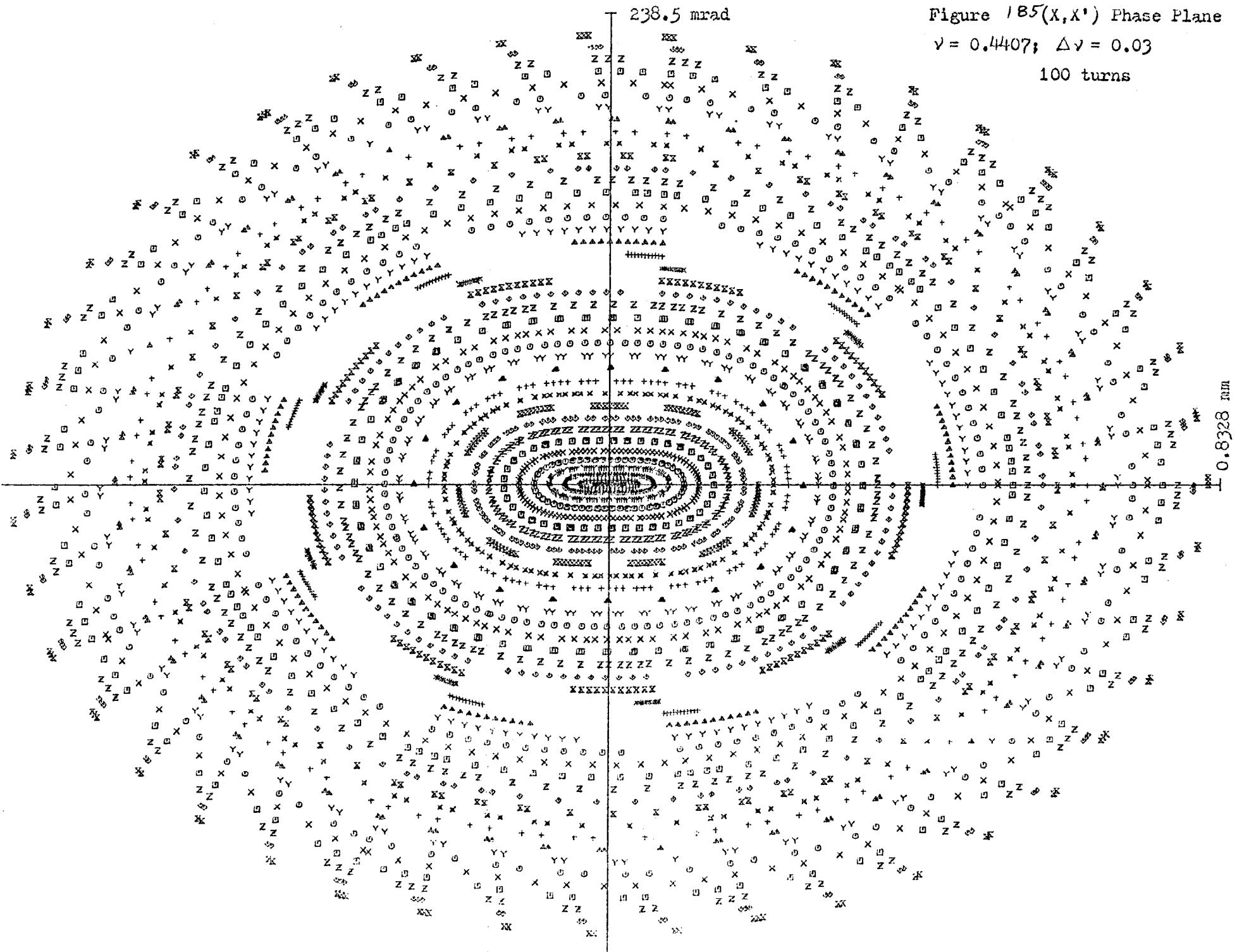


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Figure 184 (X, X') Phase Plane
 $\gamma = 0.4311$; $\Delta\gamma = 0.035$
100 turns





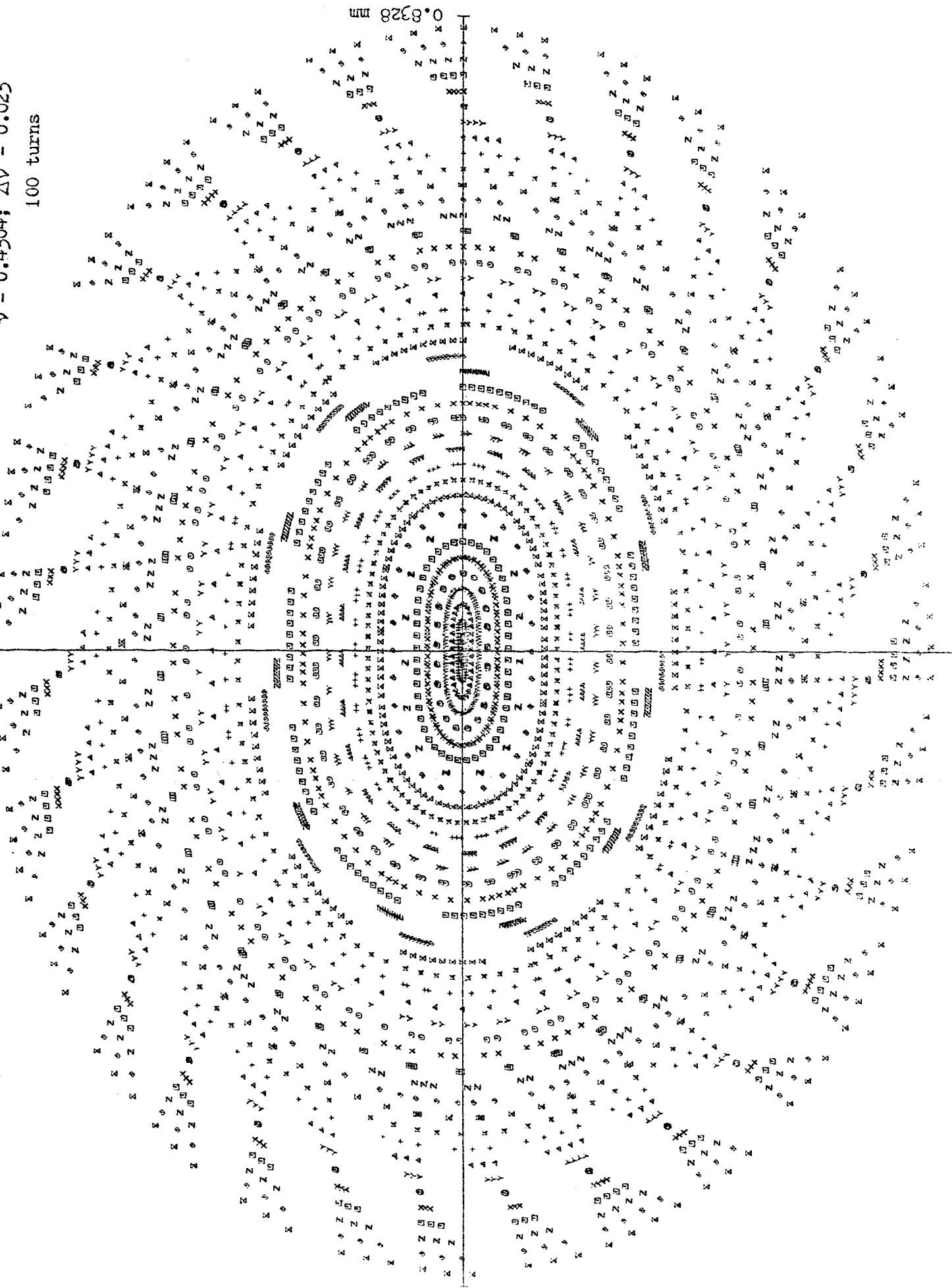
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T 201.3 mrad

Figure 1B6(λ, λ') Phase Plane

$$\nu = 0.4504; \Delta\nu = 0.025$$

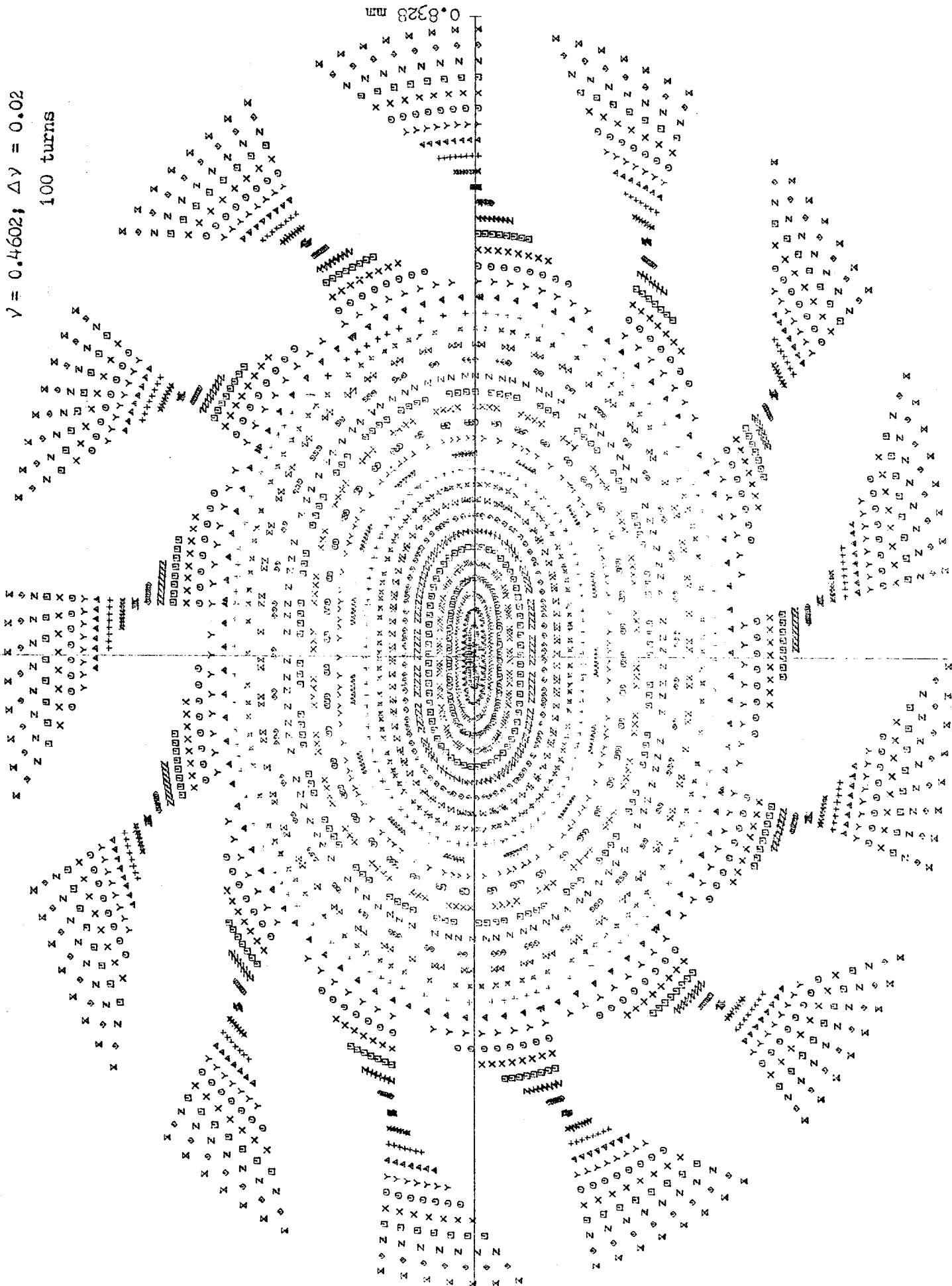
100 turns



161.8 mrad

Figure 187 (X, X') Phase Plane $\gamma = 0.4602; \Delta\gamma = 0.02$

100 turns

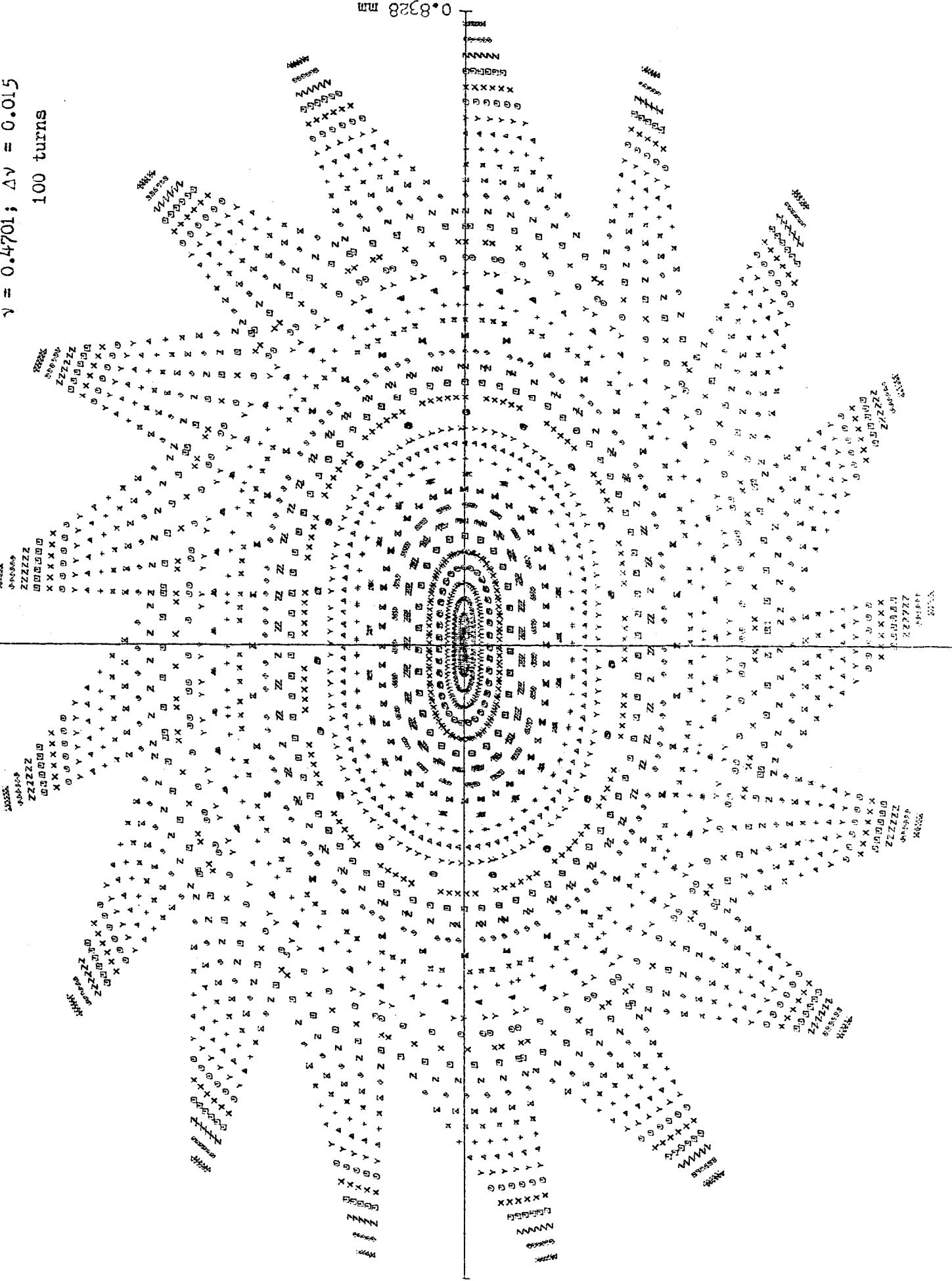


T 121.9 mrad

Figure 108 (X, X') Phase Plane

$$\gamma = 0.4701; \Delta\gamma = 0.015$$

100 turns



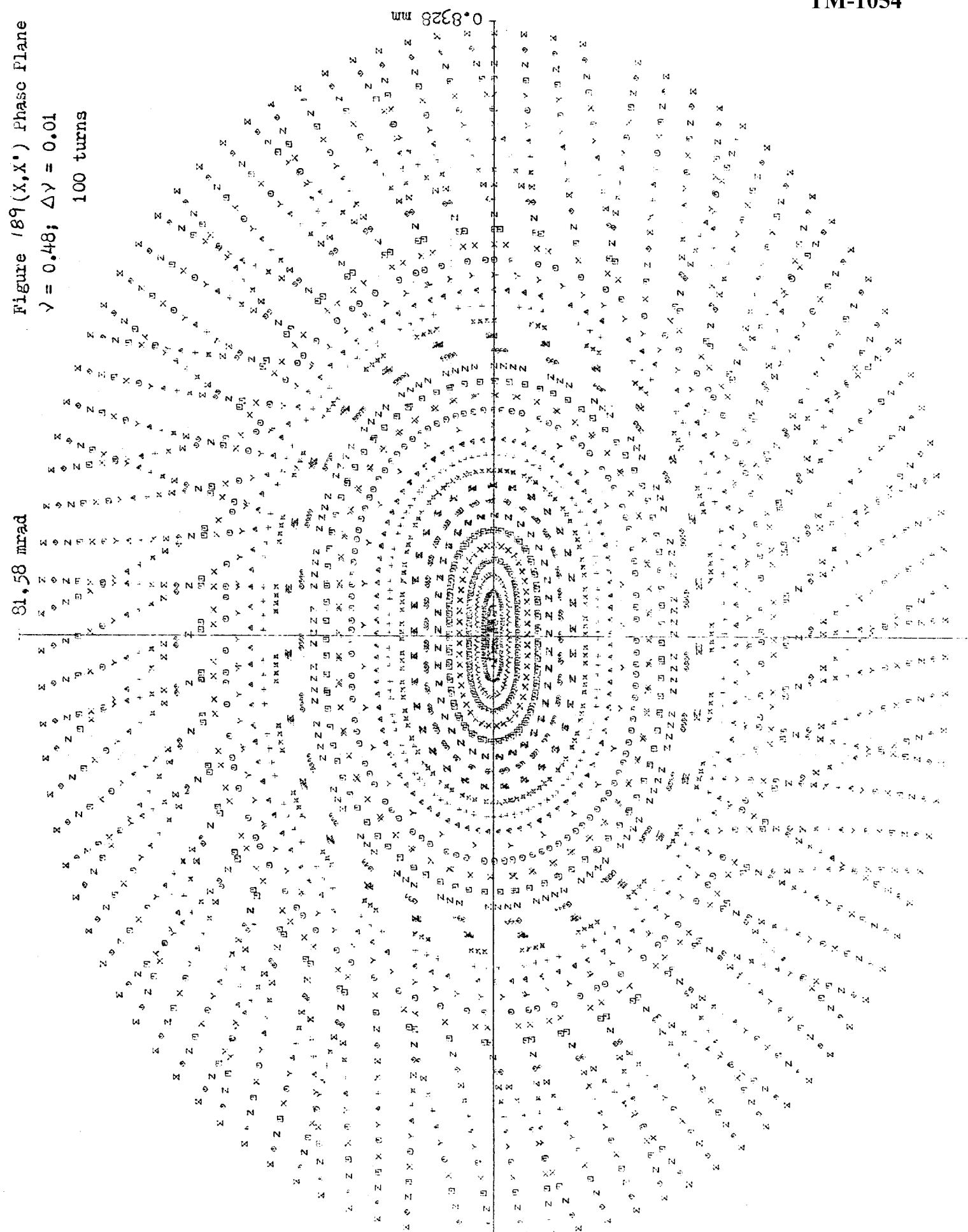
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Figure 189 (X,X') Phase Plane

81,58 mrad

 $\gamma = 0.48; \Delta\gamma = 0.01$

100 turns



40.87 mrad

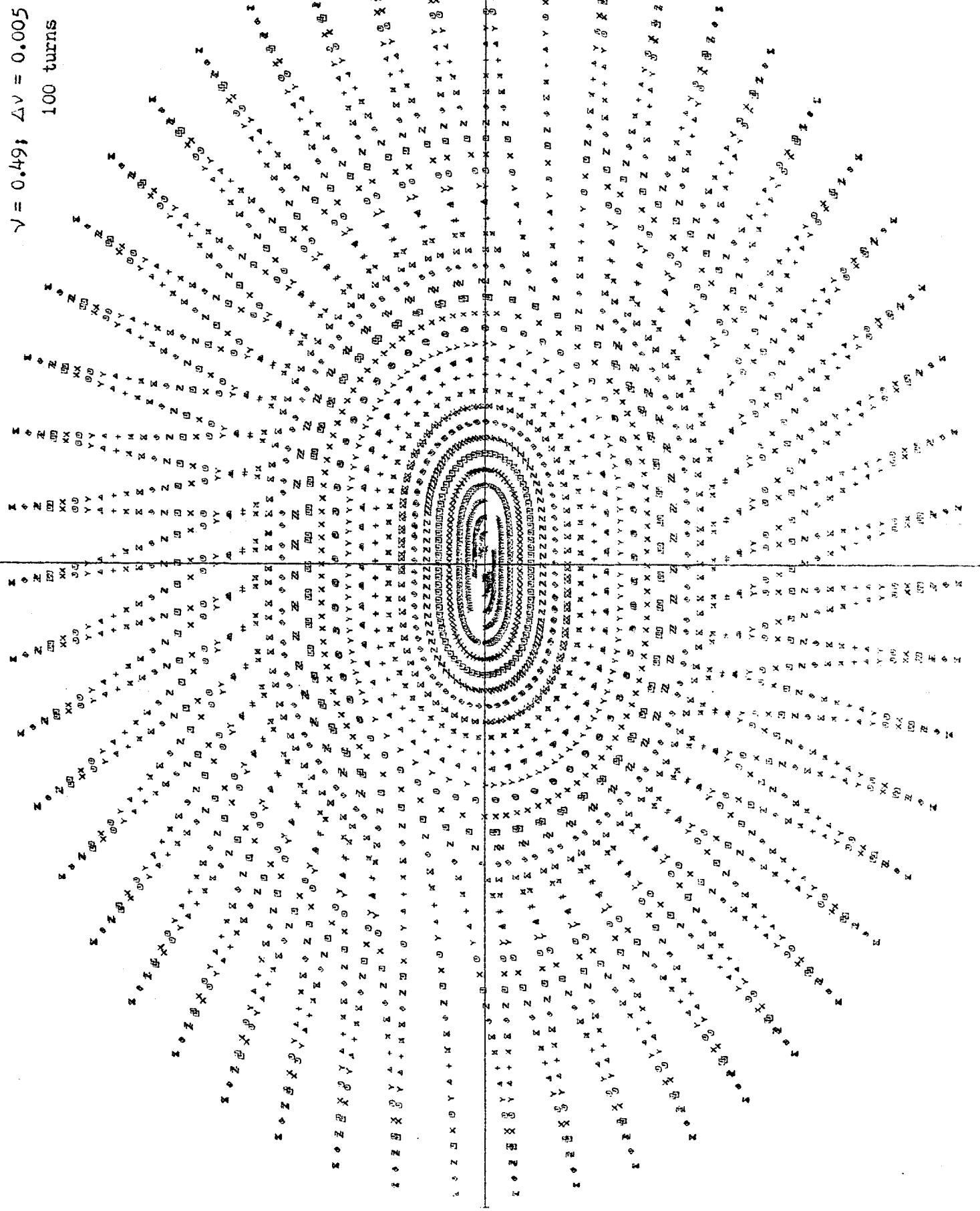
Figure 19O(λ, λ') Phase Plane

Figure 191 (X, X') Phase Plane
 $\gamma = 0.4999; \Delta v = 0; X'_0 = 0$
 $X_0 = 0.25\tau, 0.5\tau, \dots, 10\tau$
 $\sigma\tau = 0.08165 \text{ min}; 100 \text{ turns}$

