

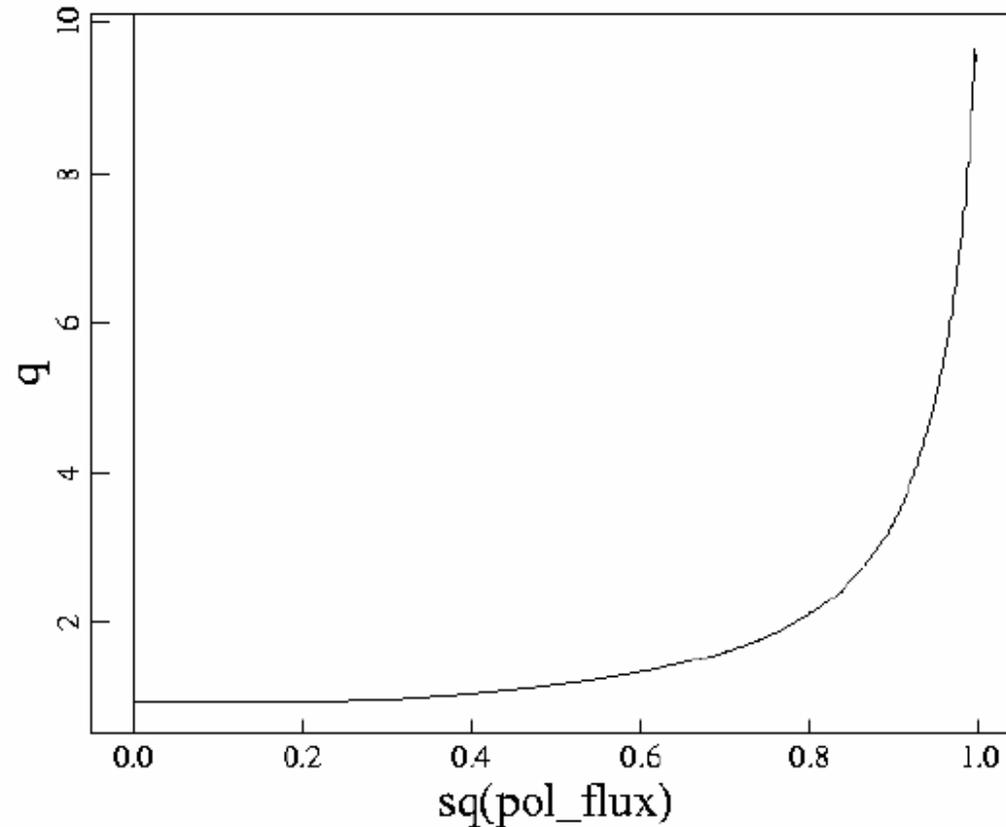


PRELIMINARY RESULTS OF SIMULATION OF A SAWTOOTH CRASH IN CDXU WITH $q(0) = 0.98$

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CDXU EQUILIBRIUM - $q(0) = 0.97$

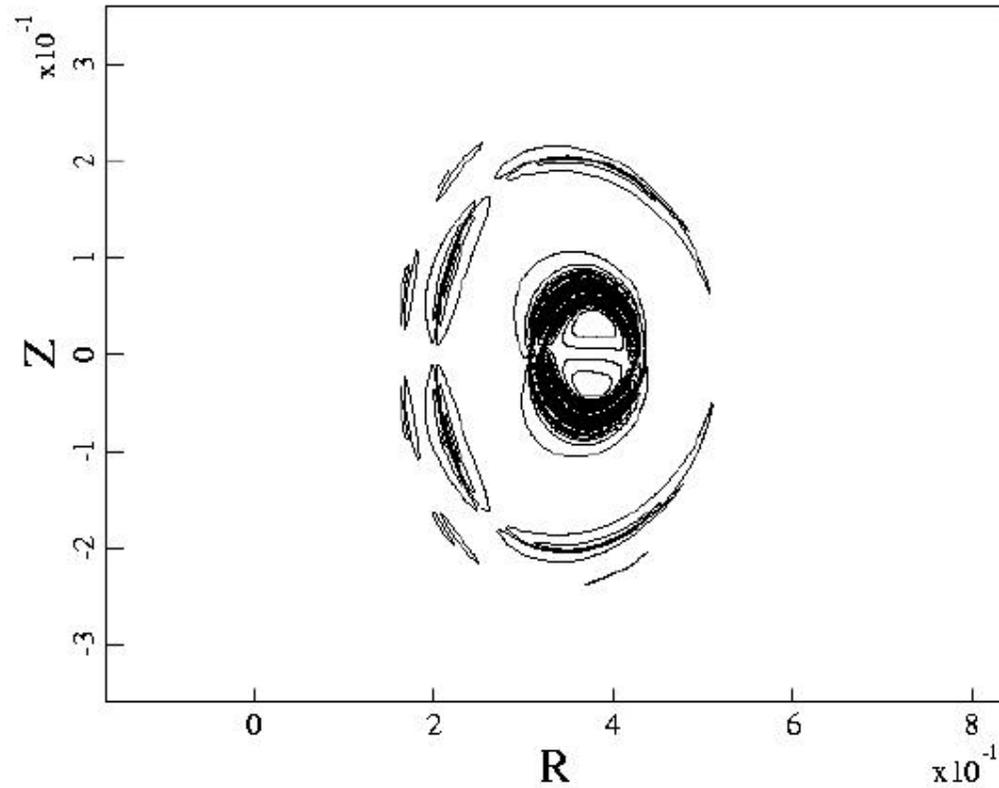
- $q_0 = 0.97$
- $P_e = 0.95 P$
- $k_{\parallel} = 1 \text{ m}^2/\text{sec}$
- $k_{\text{perp}} = 10^8 \text{ m}^2/\text{sec}$
- Spitzer resistivity
- $S = 1.9 \times 10^4$
- $Pr = 10^2$
- 50 X 50 poloidal grid
- Bi-quartic elements
- 11 toroidal modes
 - $n = 0-10$
- 176 cpus on seaborg



LINEAR STABILITY - LOW $q(0)$

- Two low- n modes are linearly unstable (in nonlinear run)
- $n = 1$
 - Sawtooth mode
 - Dominant $m = 1$, but small $m = 2$ component
- $n = 2$
 - $m = 2$ mode dominant
 - $m = 3$ and $m = 4$ components
- $n = 3, 4, \dots, 10$
 - No sign of linear instability

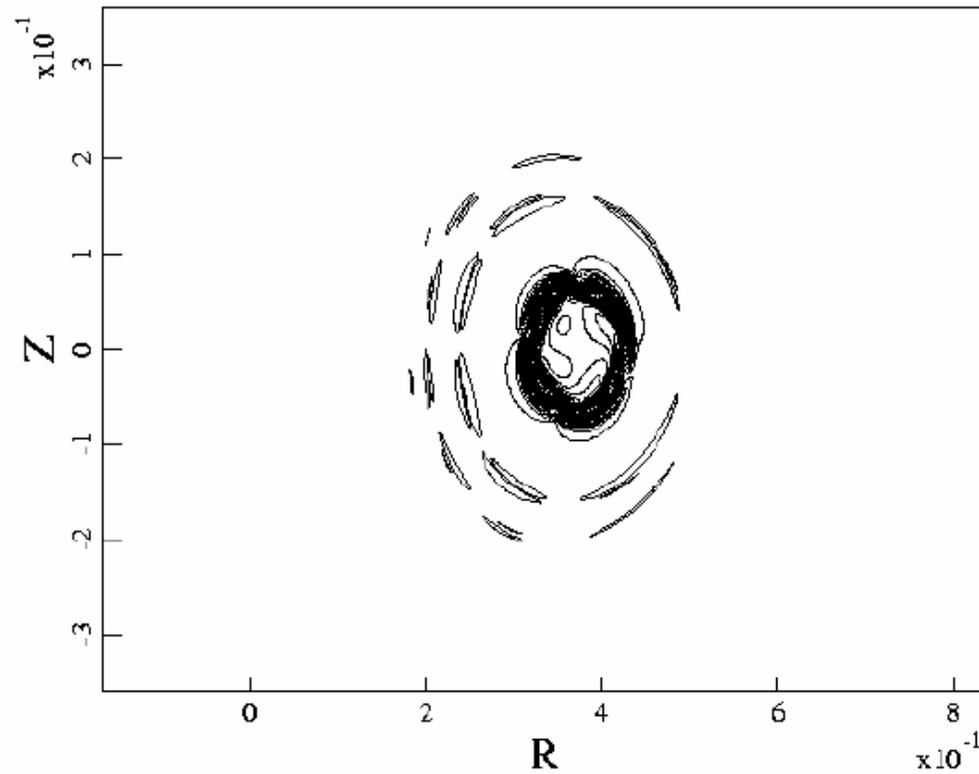
LINEAR EIGENFUNCTION - $n = 1$



$n = 1 J_f$

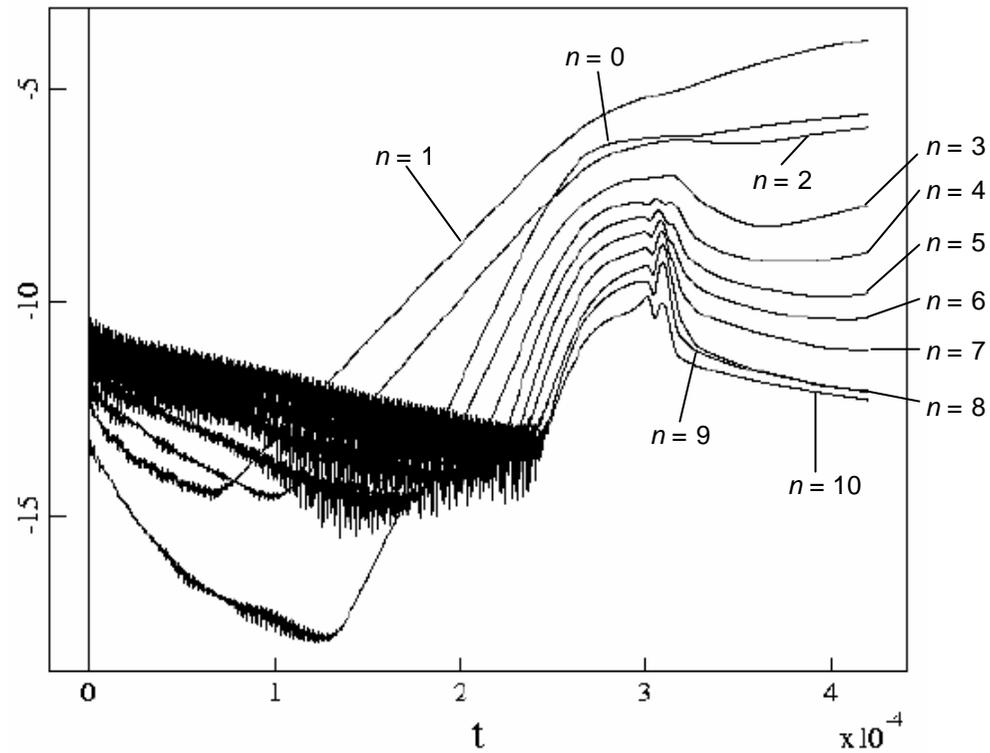
$m = 1$ and $m = 2$ ($m = 3$?)

LINEAR EIGENFUNCTION - $n = 2$



$$n = 2 J_f$$
$$m = 2 \text{ and } m = 3 \text{ (} m = 4 \text{?)}$$

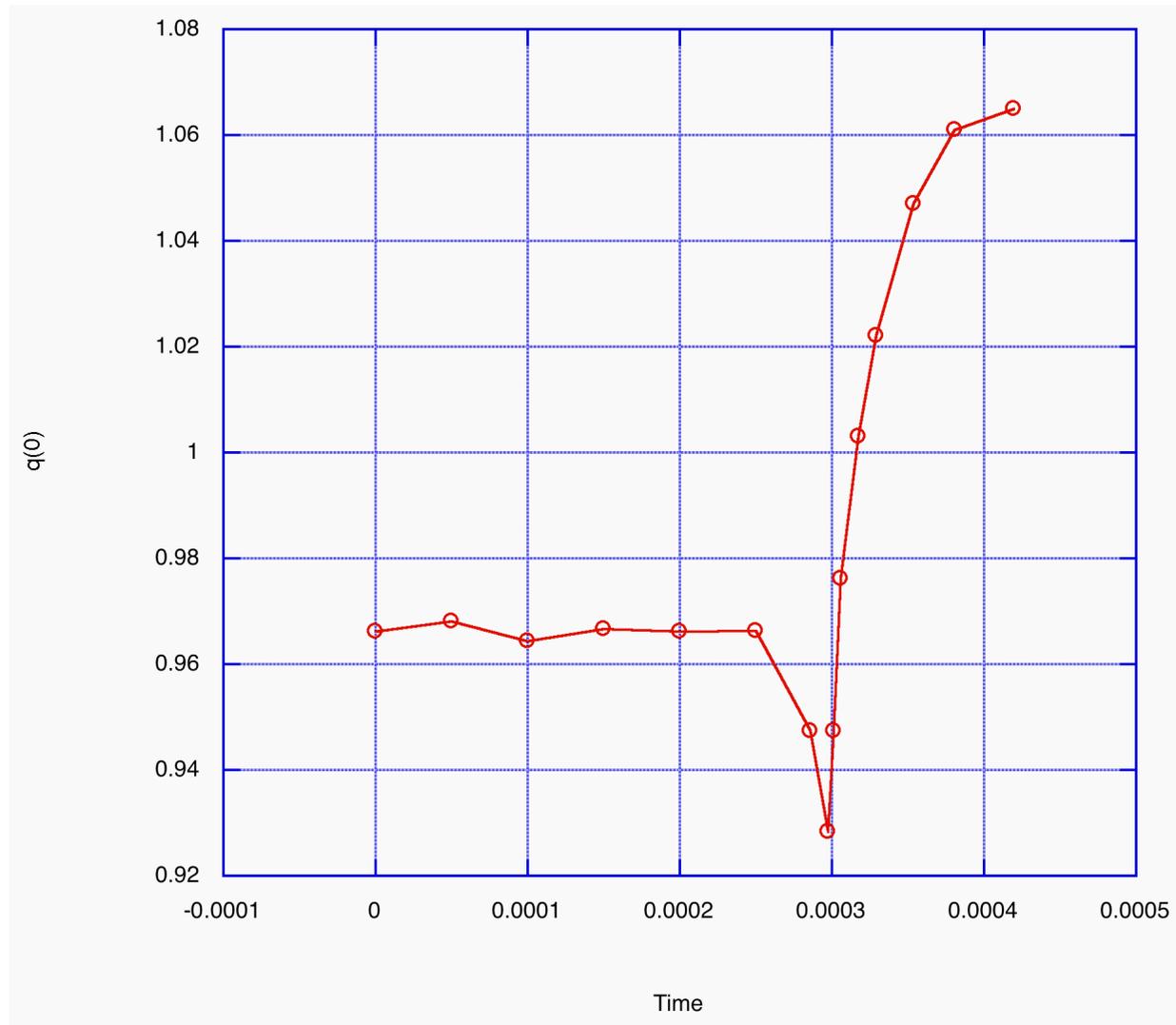
NONLINEAR CALCULATION



Kinetic Energy vs. time

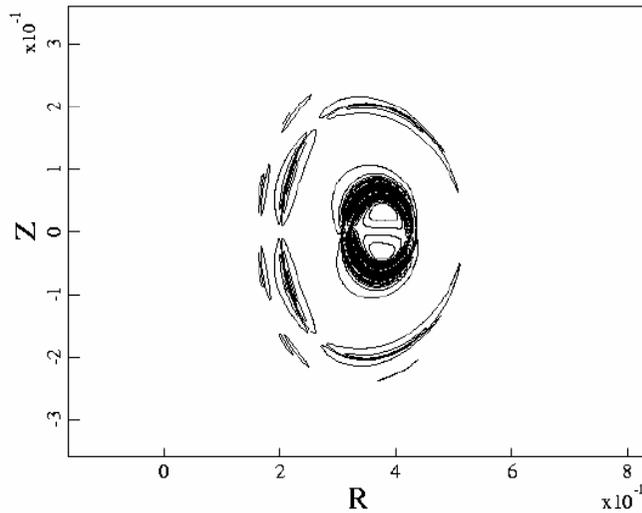
- $n = 1, 2$ linearly unstable
- $n = 0, 3-10$ nonlinearly driven
- $n = 1$ changes from $1/1$ to $2/1, 3/1$, etc and continues to grow \rightarrow tearing modes?

EVOLUTION OF $q(0)$



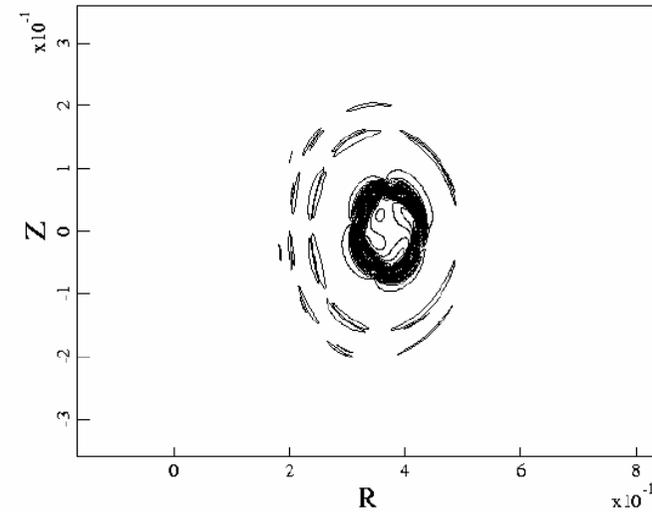
$n = 1$ MODE CHANGES CHARACTER

Before sawtooth saturation



$t = 2.5 \times 10^{-4}$ sec.

After sawtooth saturation

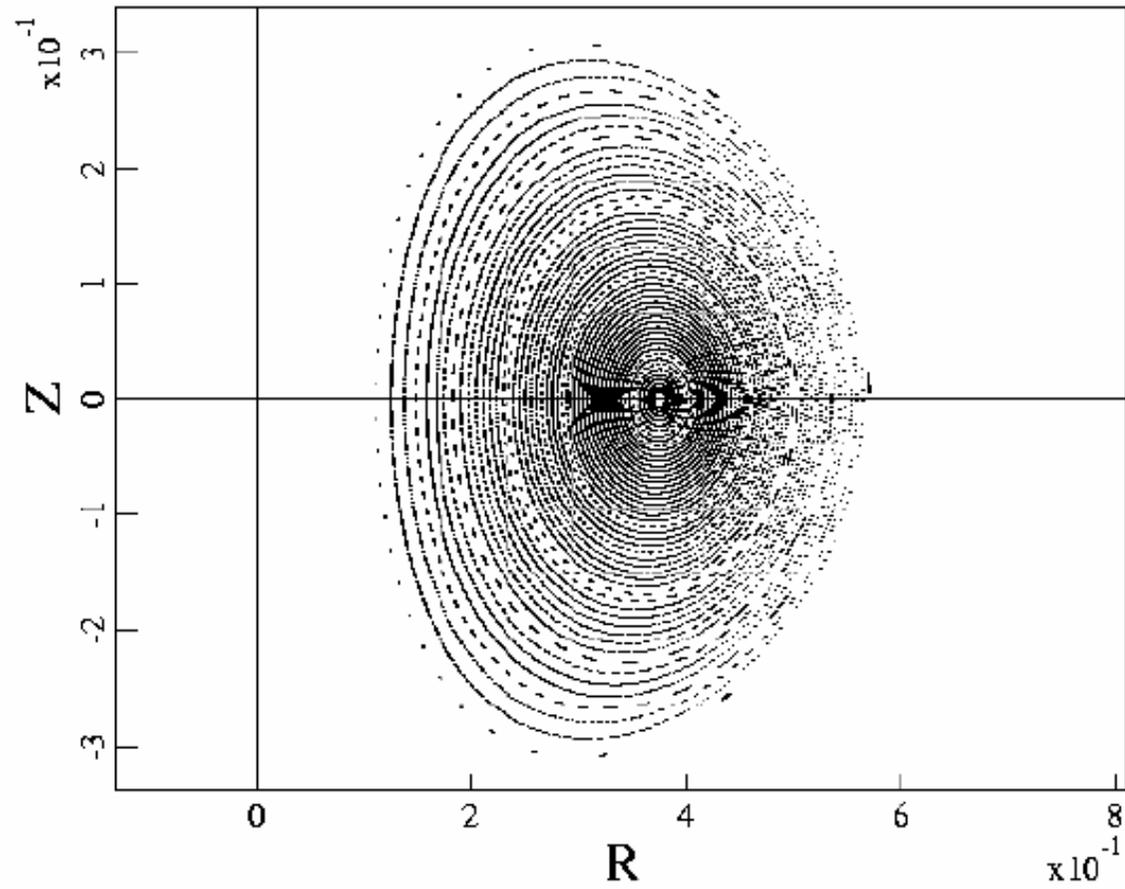


$t = 4.20 \times 10^{-4}$ sec.

- 1/1, 2/1, 3/1, ...
- Kink mode with harmonics

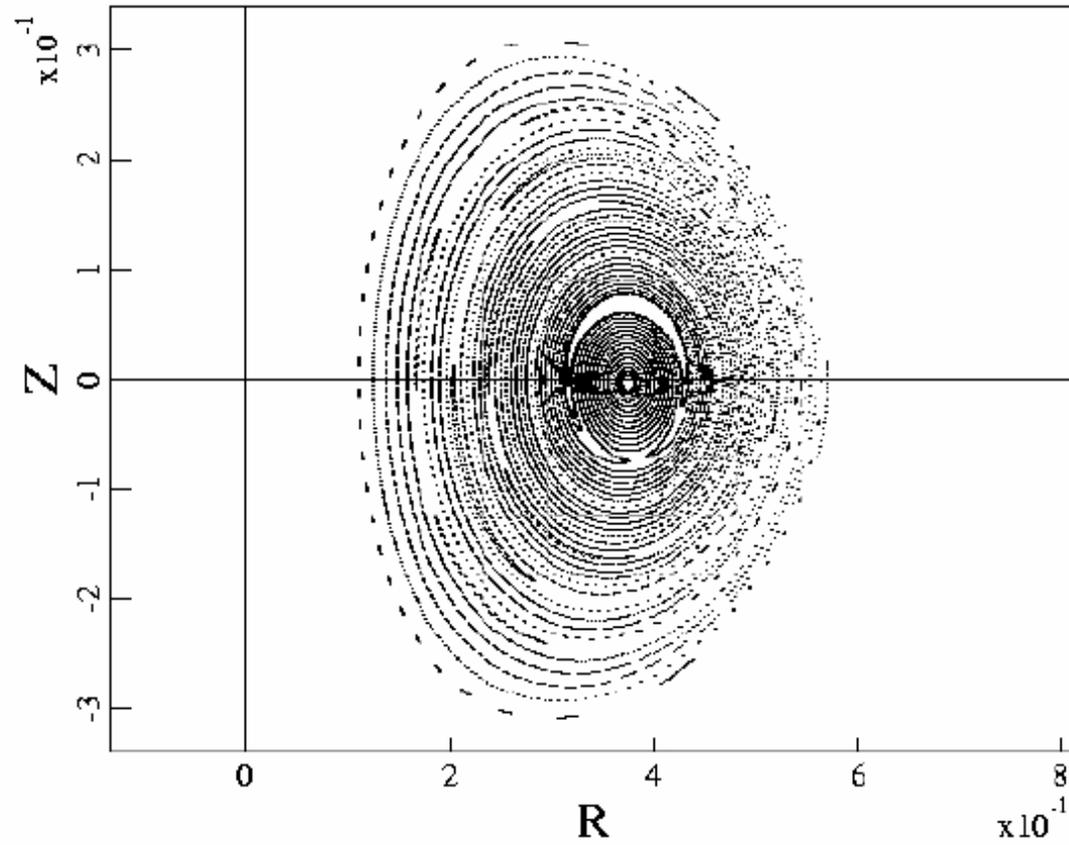
- 2/1, 3/1, 4/1, ...
- Tearing modes?

FIELD LINES



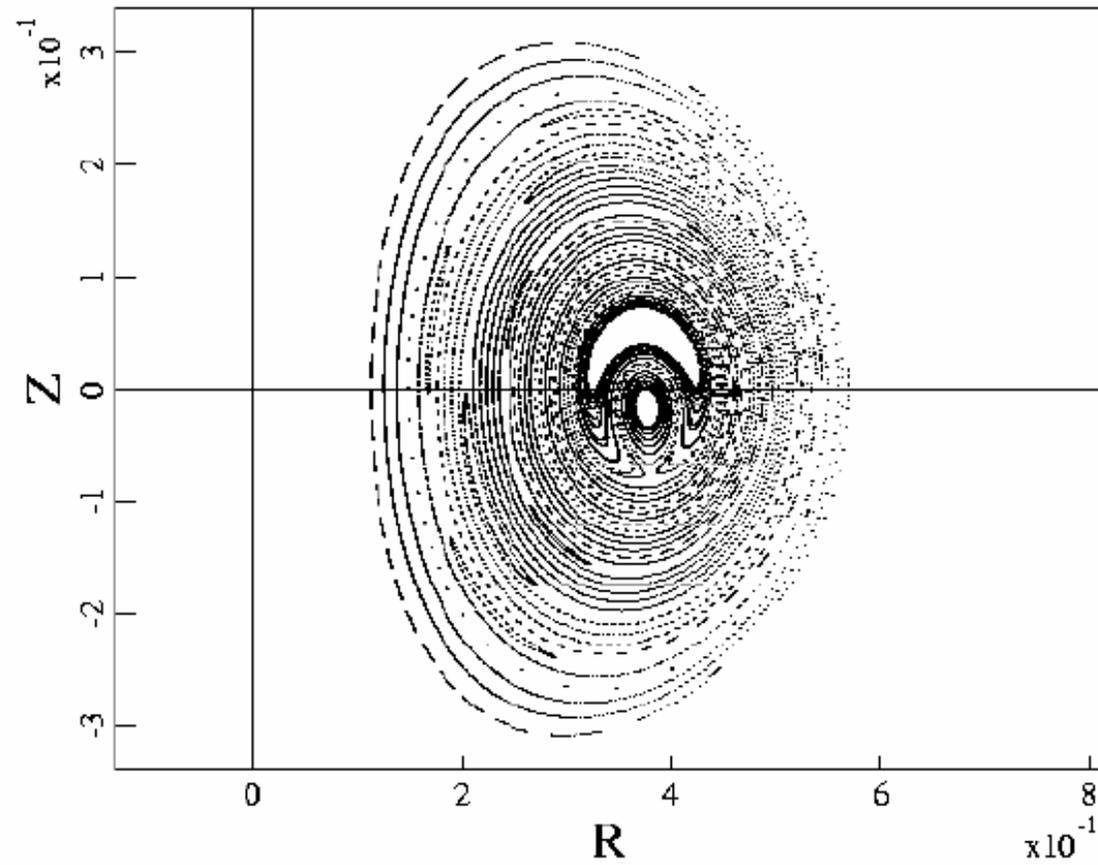
$t = 0$ sec.

FIELD LINES



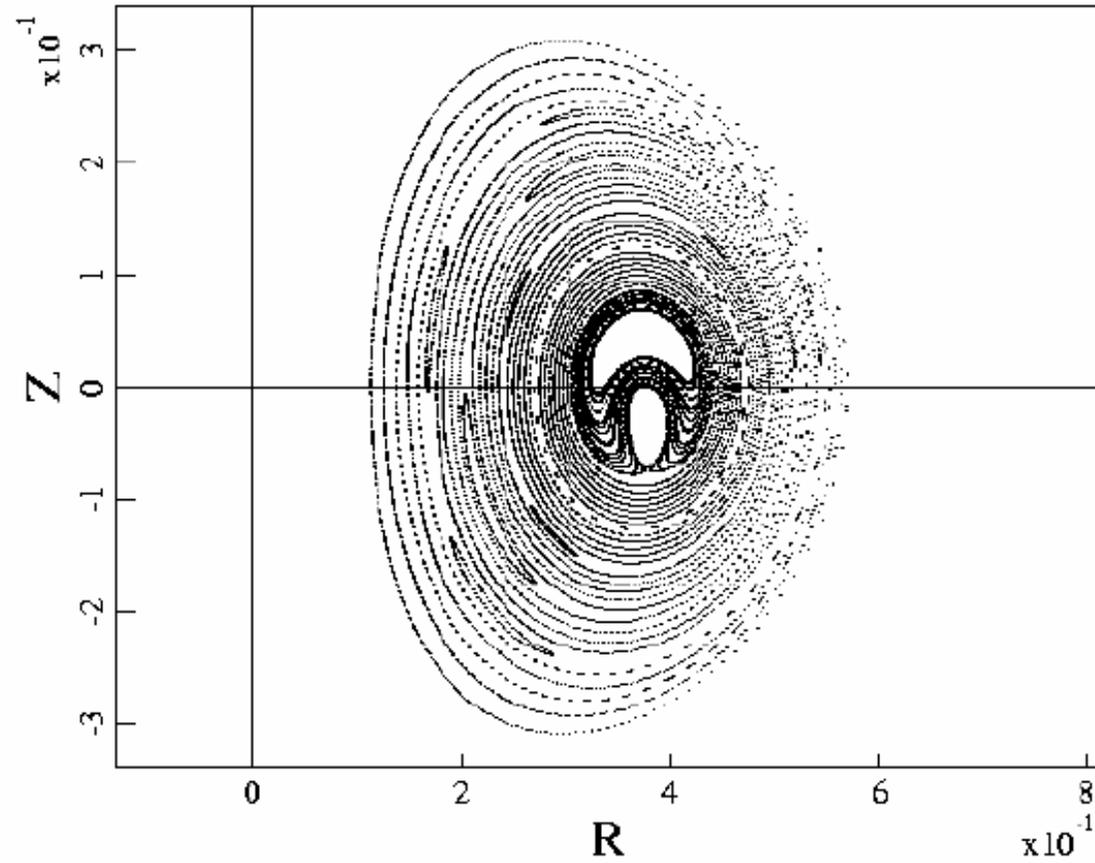
$t = 2.5 \times 10^{-4}$ sec.

FIELD LINES



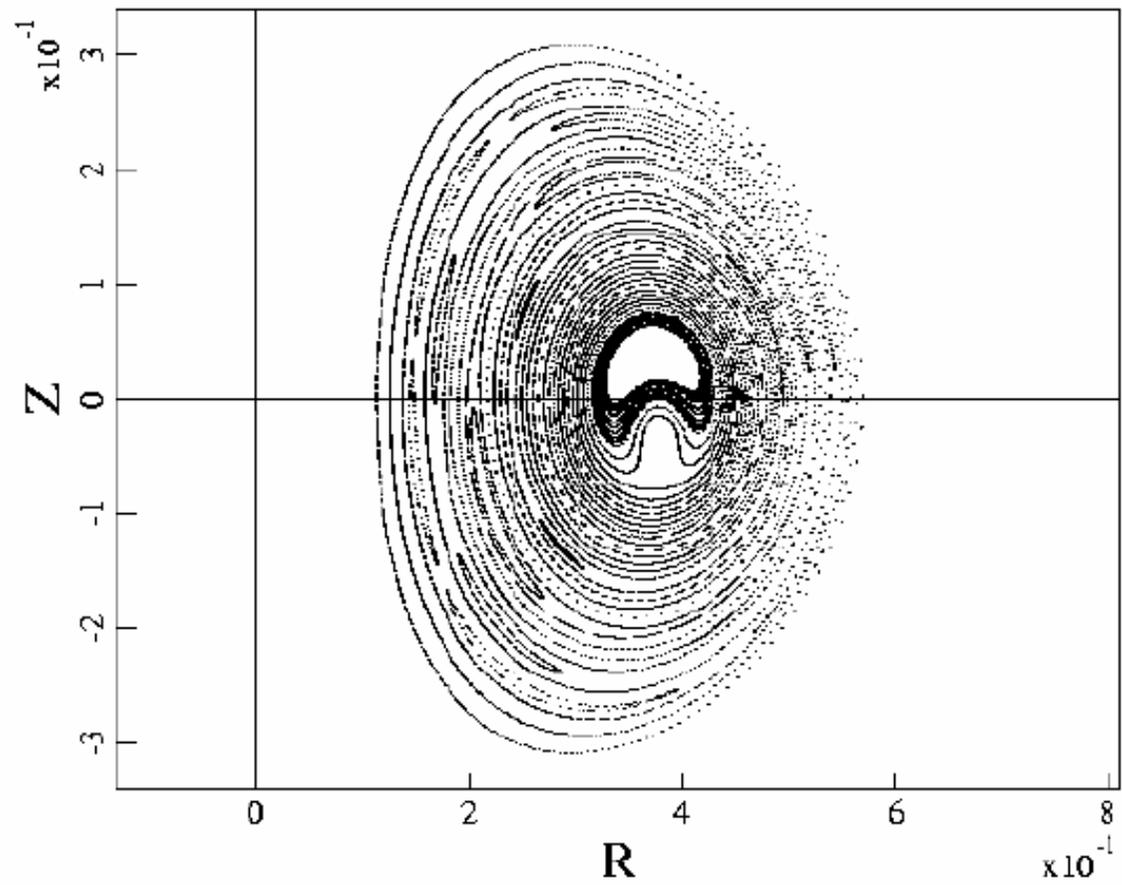
$t = 2.86 \times 10^{-4}$ sec.

FIELD LINES



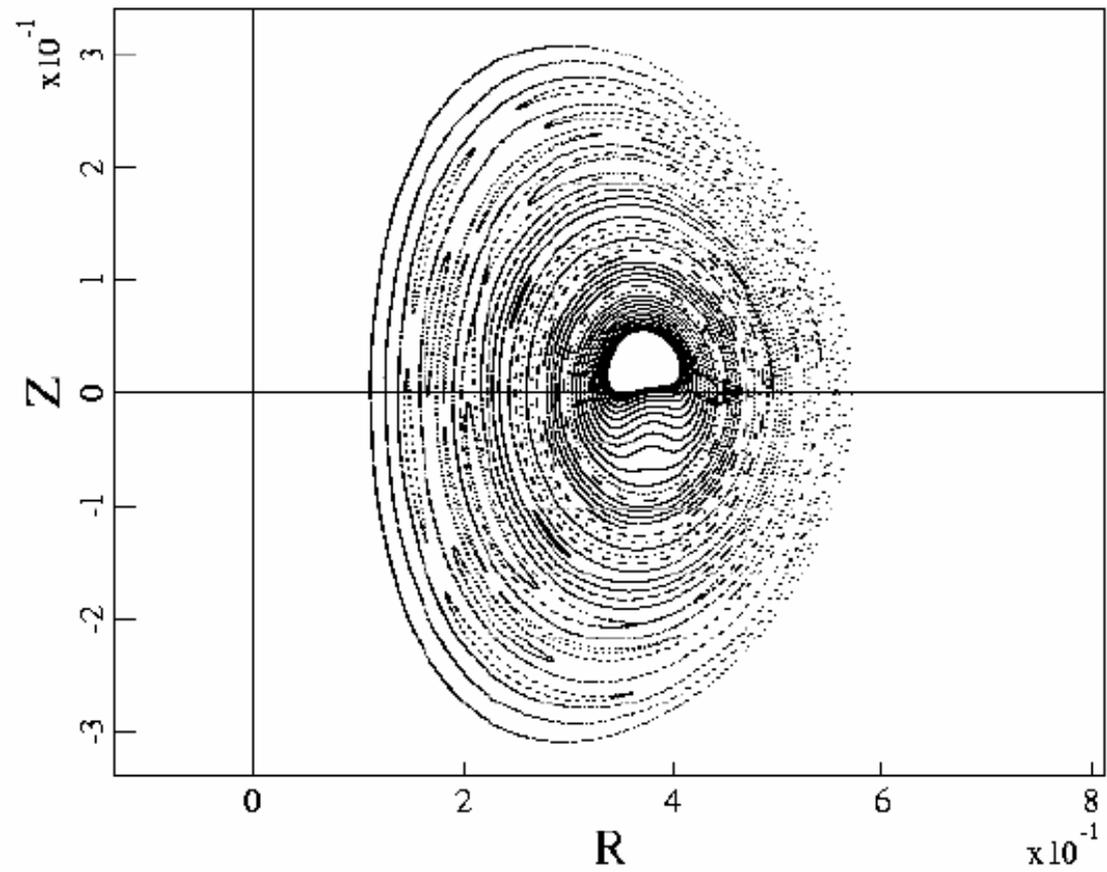
$t = 2.97 \times 10^{-4}$ sec.

FIELD LINES



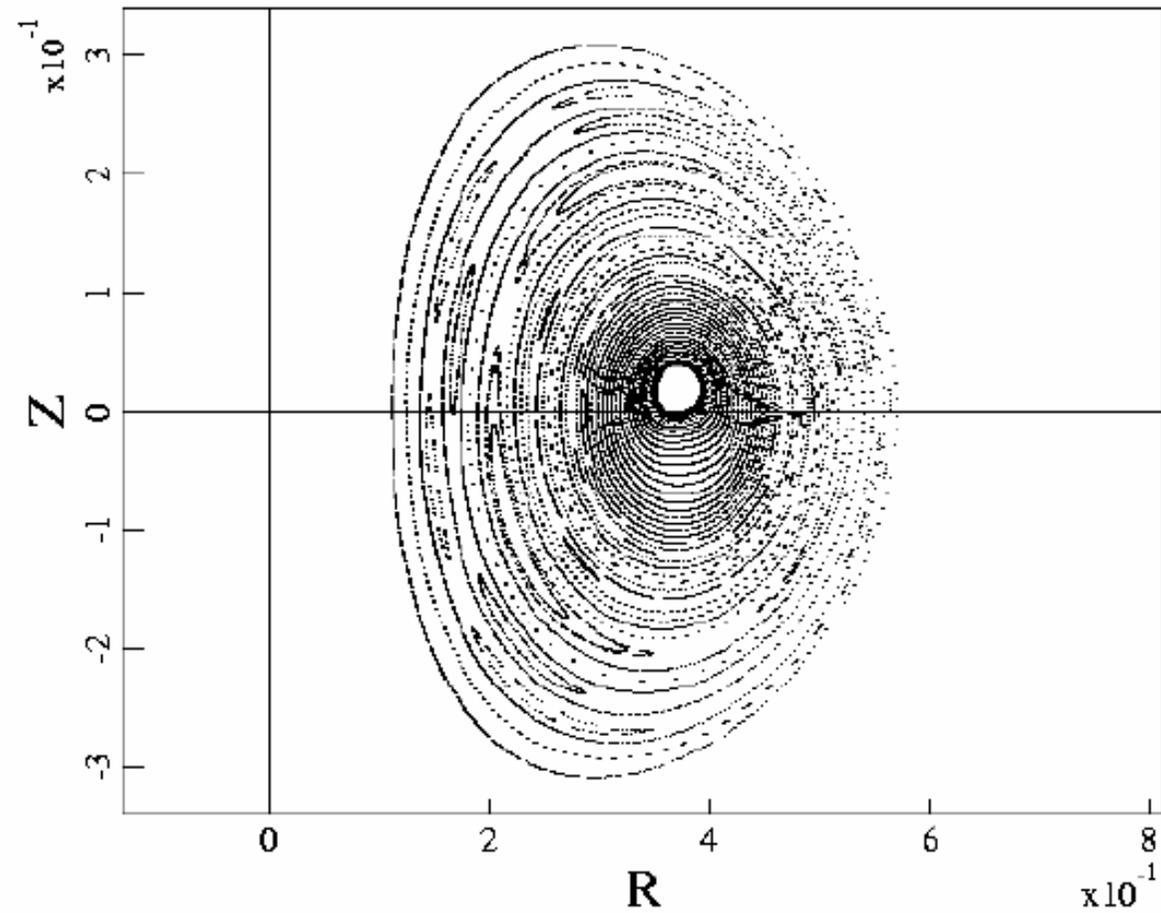
$t = 3.06 \times 10^{-4}$ sec.

FIELD LINES



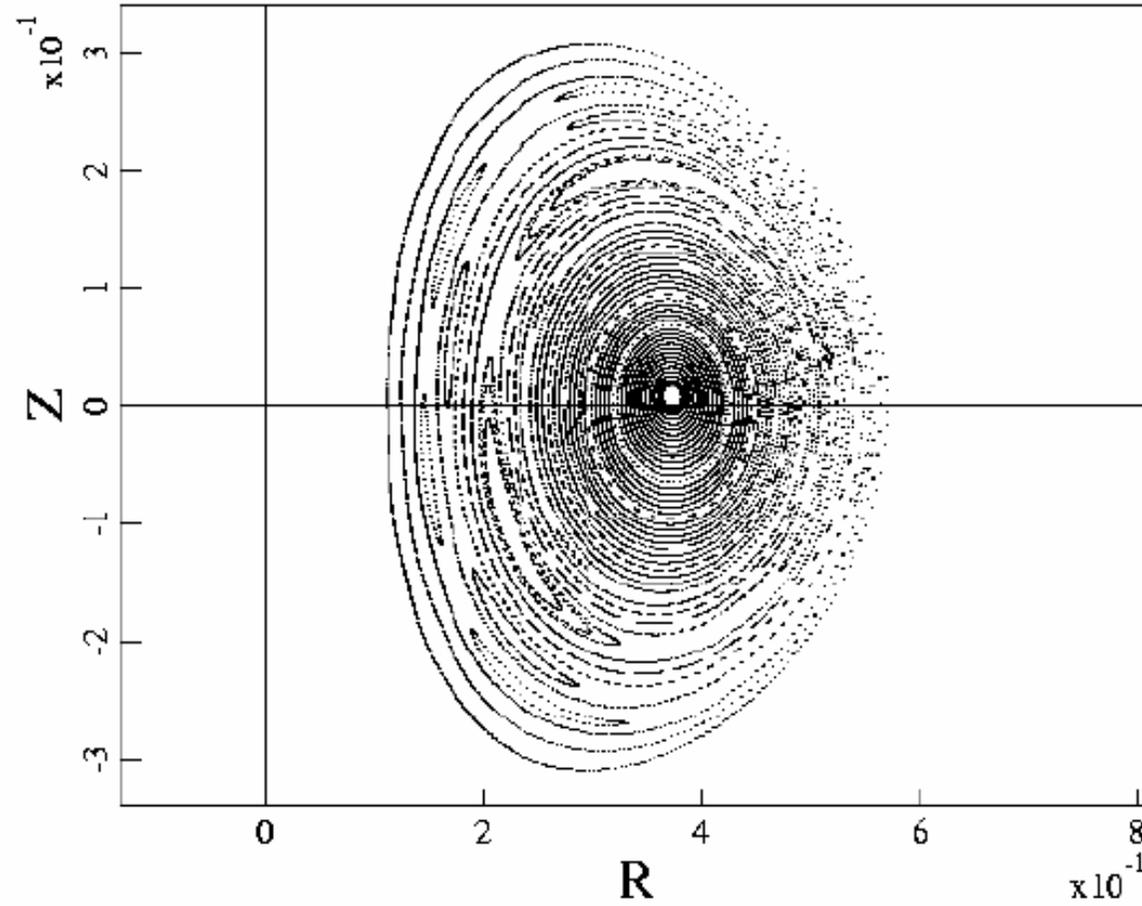
$t = 3.17 \times 10^{-4}$ sec.

FIELD LINES



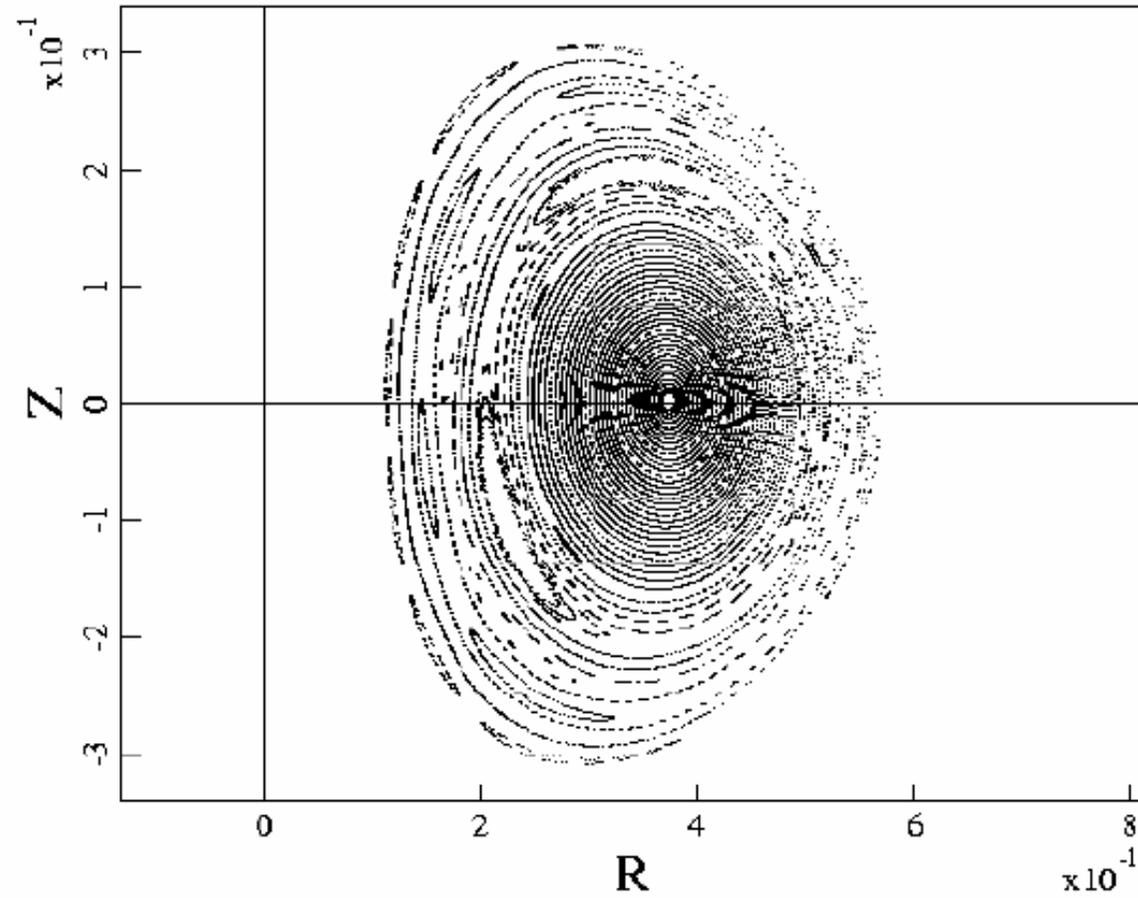
$t = 3.29 \times 10^{-4}$ sec.

FIELD LINES



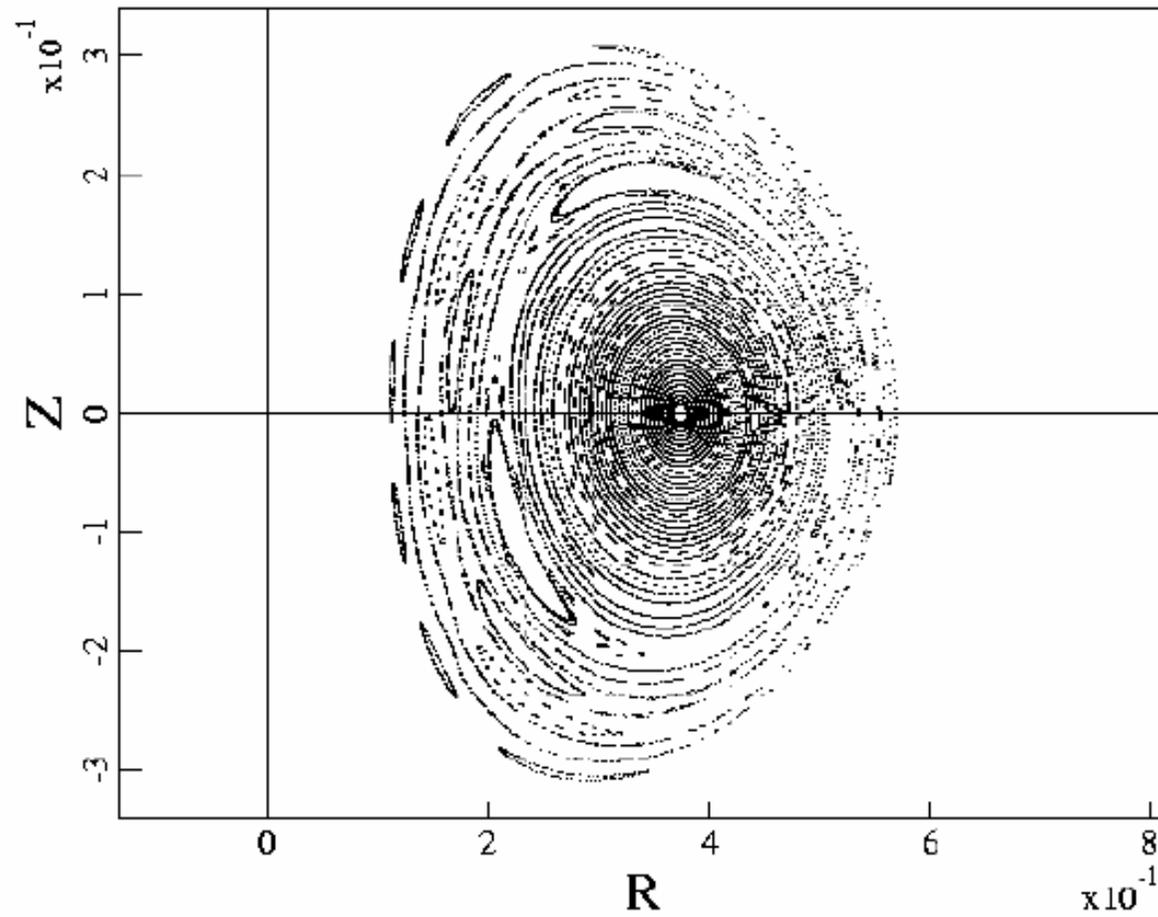
$t = 3.54 \times 10^{-4}$ sec.

FIELD LINES



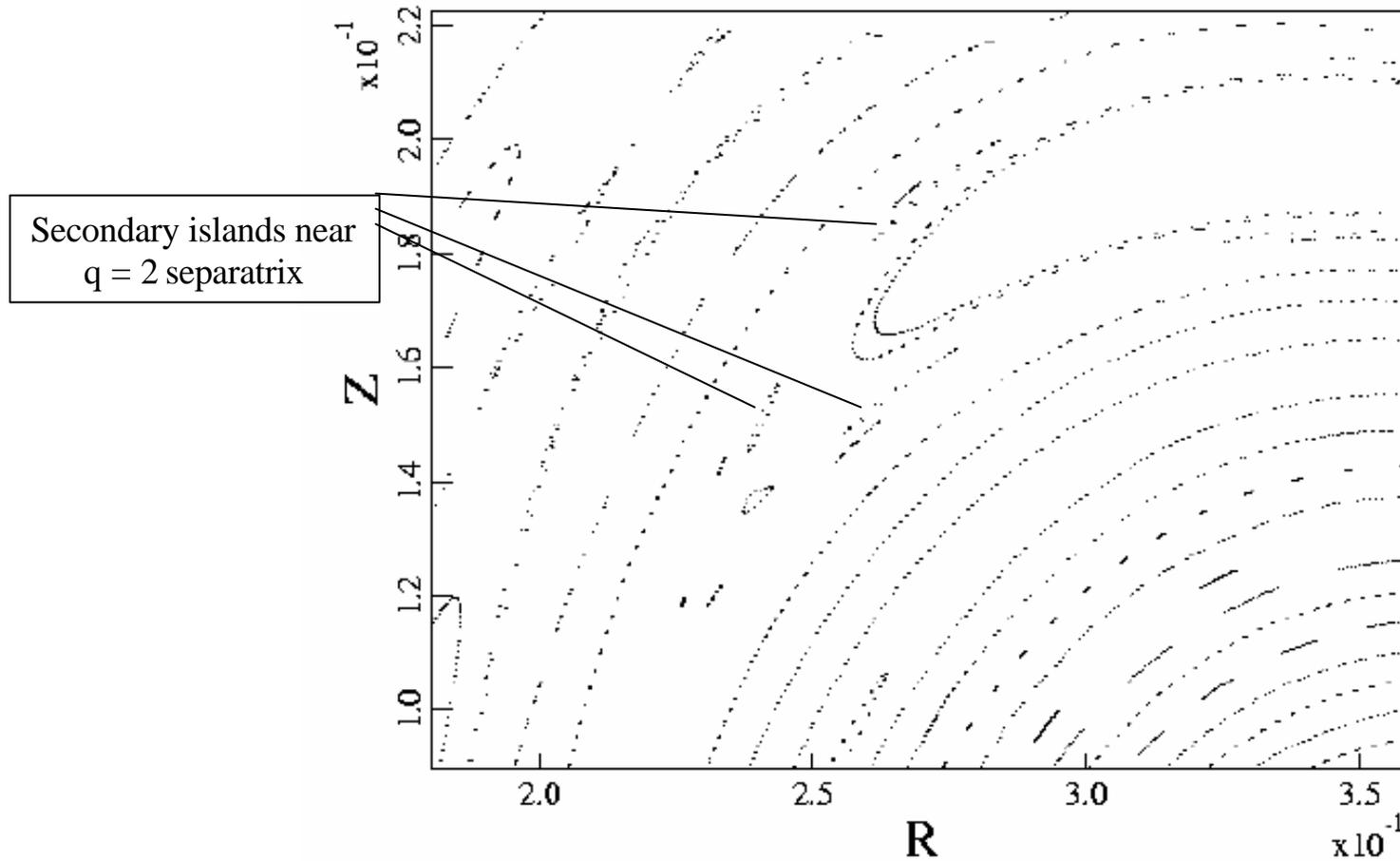
$t = 3.81 \times 10^{-4}$ sec.

FIELD LINES



$t = 4.20 \times 10^{-4}$ sec.

DETAIL OF FIELD LINE STRUCTURE NEAR $q=2$ SURFACE



$t = 4.20 \times 10^{-4}$ sec.

Onset of stochasticity?

COMMENTS

- **Sawtooth ($n = 1$) mode grows and saturates**
 - $n = 2$ also linearly unstable
 - $q(0)$ is raised above 1
 - $q(0)_{\text{max}} \sim 1.065$
- $n = 1$ mode changes character after sawtooth saturation
 - Changes from 1/1 to 2/1, 3/1,
 - Transition from kink mode to tearing mode?
- **Field does not become completely stochastic for as long as case was run**
 - Many secondary islands around 2/1 separatrix
 - Need to run further to determine stochasticity
 - Interesting to look at $q(0) > 1$ case