
Born on May 20, 1940
Wir wollen Arbeit und Brot! wählt Hitler!
Palm
Reichssportfeld. Die Dietrich-Eckart-Freilichtbühne

Deutscher Amateur Radio Club

DL9: Individual licences with full privileges

1951-1959: Gymnasium, Tübingen

1959-1965: Medicine,
University of Tübingen

1966 : Medical doctor
from the University of Tübingen

Topic: ***Long-term Immunization of Albino Mice with Bovine Gamma Gl***

Konrad Lorenz (1903-1989) Eric von Holst (1908-1962)

1966-1967: Federal-money stipend holder
at Max-Planck Institute for the Physiology of Behavior, SeeWiesen

1967-1969: Medical assistant
University of Marburg

1969-1970: ***Center for Theoretical Biology***
State University of New York at Buffalo

Robert Rosen (1934-1998)

1970: Assistant (working with Friedrich Seelig)
Department for Theoretical Biology, University of Tübingen

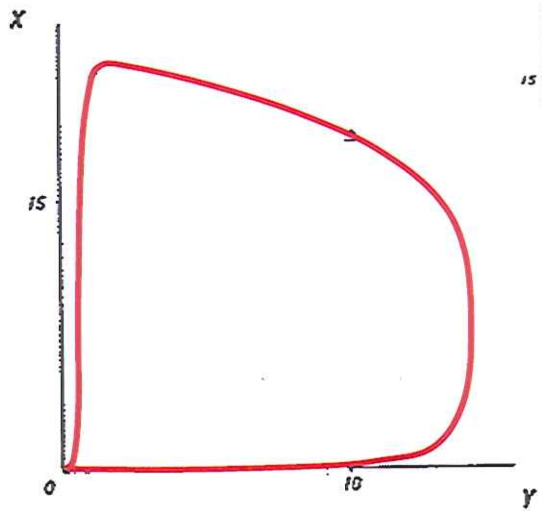
Dietrich Hoffmann

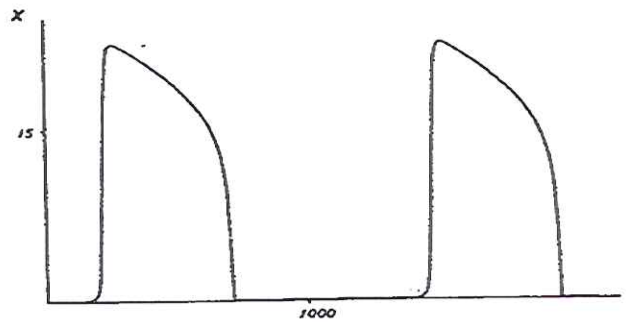
REPETITIVE HARD BIFURCATION IN A HOMOGENEOUS REACTION SYSTEM

O. E. RÖSSLER and D. HOFFMANN
Division of Theoretical Chemistry, University of Tübingen,
West Germany

Analysis and Simulation of Biochemical Systems, 91-102, 1972

This paper consists of three parts. First, theoretical evidence that the Belousov-Zhabotinsky reaction (BZR) is a Bonhoeffer oscillator, i.e. a special type of chemical hysteresis oscillator, is presented. Second, a brief account of the qualitative theory of chemical relaxation oscillators is given, centering around the notion of hard bifurcation. Finally, some connections between homogeneous and nonhomogeneous chemical bifurcat- ... pointed out.





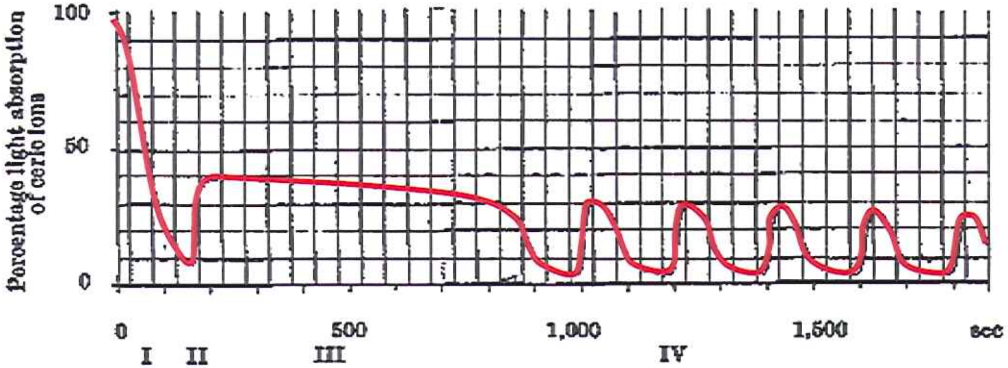
CHEMISTRY

NATURE, FEBRUARY 11, 1967

Effect of Bromine Derivatives of Malonic Acid on the Oscillating Reaction of Malonic Acid, Cerium Ions and Bromate

Chemistry Laboratory III,
H. C. Ørsted Institute,
University of Copenhagen.

Hans Degn

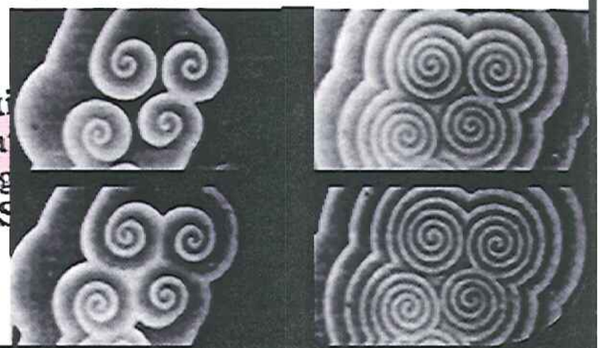


Spiral Waves of Chemical Activity

Abstract. *The Zhabotinsky-Zaikin reagent propagates waves of chemical activity. Reaction kinetics remain to be fully resolved, but certain features of wave behavior are determined by purely geometrical considerations. If a wave is broken, then spiral waves, resembling involutes of the circle, appear, persist, and eventually exclude all concentric ring waves.*

ARTHUR T. WINFREE
Department of Theoretical Biolo
University of Chicago,
Chicago, Illinois 60637

A. Zhabotinsky mentions spiral waves in oscillating reagent on page 29 of "Investi tion of homogeneous chemical auto-oscilla systems" (in Russian) (Institute of Biolog Physics of the Academy of Sciences, U.S.S Puschino, 1970).



INTERNATIONALER KONGRESS ÜBER
„RHYTHMISCHE FUNKTIONEN IN BIOLOGISCHEN SYSTEMEN“

INTERNATIONAL CONGRESS ON
“RHYTHMIC FUNCTIONS IN BIOLOGICAL SYSTEMS”

CONGRES INTERNATIONAL SUR
“LES FONCT[...]S RYTHMIQUES DANS DES SYSTEMES BIOLOGIQUES”

Wien/Vienna/Vienne, 8.—12. 9. 1975

Vienna, September 12,1975

This is to certify that

Dr. RÖSSLER participated in the International Congress on "Rhythmic Functions in Biological Systems" and paid the registration fee amounting to

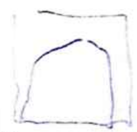
AS 300.—

KONGRESSBÜRO
der Wr. med. Akademie
für ärztliche Fortbildung
Wien IX. Alserstraße

Vienna, September 8-12, 1975

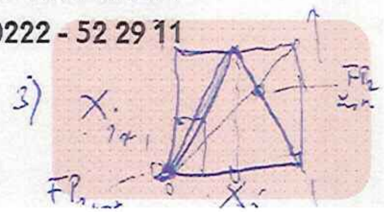
Konsumgüterleasing
Elektro-Radio-Fernsehen
Sämtliche
Gartengeräte
Haushalts-
und Freizeitartikel
Baumaschinen

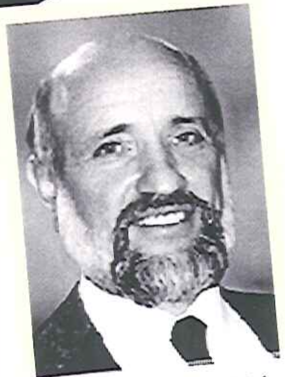
Informieren
Sie sich
über unser Waren-Kredit-Service



KOHLMARKT 5/II
A-1010 WIEN
Ø 0222 - 52 92 92/52 89 29

FICHTEGASSE 1A
A-1010 WIEN
Ø 0222 - 52 29 11





October 7, 1975

PURDUE UNIVERSITY
DEPARTMENT OF BIOLOGICAL SCIENCES
WEST LAFAYETTE, INDIANA 47907

75. 9.10. / Ah. 14.10.75

« Your insight amazes me. I think you will understand this literature much better than I do... A development I would like to encourage by sending along a few choice of reprints + preprints »

~~Dear Otto~~ October

~~Your insight amazes me. I think you will understand this literature much~~ better than I do.... a development I would like to encourage by sending along a few choice reprints + preprints (coming separately)

Yes I also have been intrigued by the possibility that "core meander" betrays a deterministic "strange attractor".

And John Guckenheimer is following up the conjecture you also came to, that periodic forcing of an limit-cycle oscillator → "strange attractor". Actually it turns out a kind of "strange repellor", but

130 JOURNAL OF THE ATMOSPHERIC SCIENCES

Deterministic Nonperiodic Flow[1]

EDWARD N. LORENZ

SIAM J. APPL. MATH.
Vol. 32, No. 1, January 1977

PERIODIC SOLUTIONS OF A LOGISTIC DIFFERENCE EQUATION*

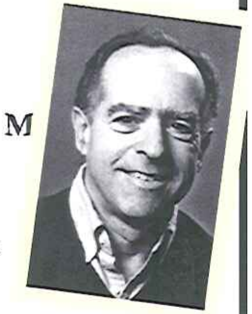
F. C. HOPPENSTEADT AND J. M. HYMAN†

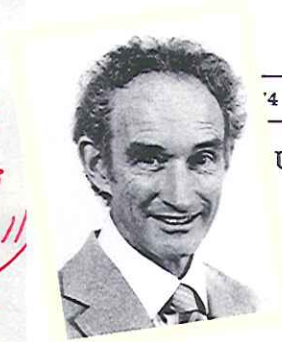
J. Math. Biology 4, 101—147 (1977)

The Dynamics of Density Dependent Population M

Journal of Mathematical Biology
© by Springer-Verlag 1977

J. Guckenheimer, Santa Cruz, California,
G. Oster and A. Ipaktchi, Berkeley, California





'4 The American Naturalist July–August 1976

URCATIONS AND DYNAMIC COMPLEXITY IN SIMPLE ECOLOGICAL MODELS

ROBERT M. MAY AND GEORGE F. OSTER

October 15, 1975

Universität Tübingen
Institut für Physikalische und
Theoretische Chemie

7400 Tübingen 1, den Oct. 15, 1975
Auf der Morgenstelle 8
Tel.: (0 70 71) 29 67 81

Institut für Physikalische und Theoretische Chemie
7400 Tübingen 1, Auf der Morgenstelle 8

Professor
Arthur T. Winfree
Department of Biological Sciences
Purdue University
West Lafayette, Indiana 47907
U.S.A.

130 JOURNAL OF THE ATMOSPHERIC SCIENCES VOLUME 20

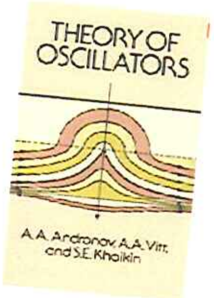
Deterministic Nonperiodic Flow[1]

EDWARD N. LORENZ

« Chemical Nonperiodic Flow, 3 examples »

I have a proposal, for a joint paper, entitled "Chemical Nonperiodic Flow, 3 Examples", with the 3 sections: 1) Periodically forced limit cycle oscillator and monoflop; 2) Application to meandering core in an excitable medium (simulation); 3) Phase-shift oscillator. The discussion part would focus on the pragmatic nature of the approach, and could mention some of the great many dynamical questions opened (limit structure of nonzero measure; violation of the separation rule (unstable attractors being separated by asymptotically stable ones; basin structure); violation of compactness (porous attractor); utilizability of the same limit set in between two unstable sources and two stable sinks, respectively; time reversal problem[1].

The universal circuit



Alexandre Andronov
(1901-1952)

...TIVIBRATOR WITH AN INDUCTANCE IN THE ANODE CIRCUIT

...ave now seen that the investigation of a self-oscillating system is ...ably simplified if one of the important oscillation parameters is small, so that the motions can be split into comparatively simple "rapid"

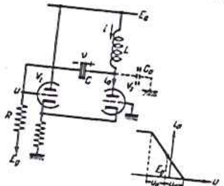
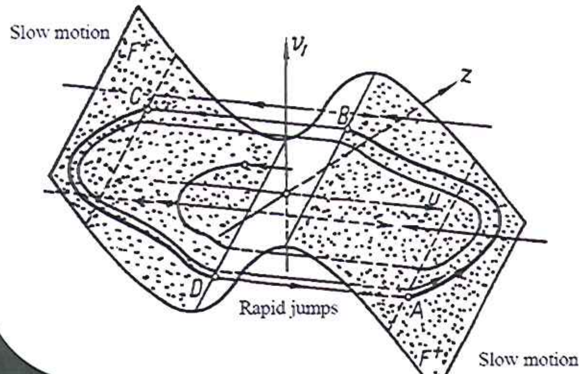
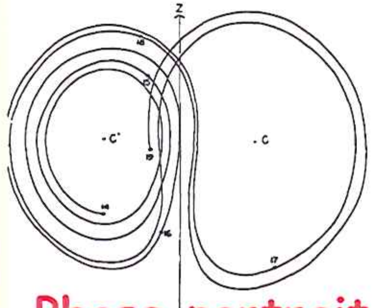


FIG. 553

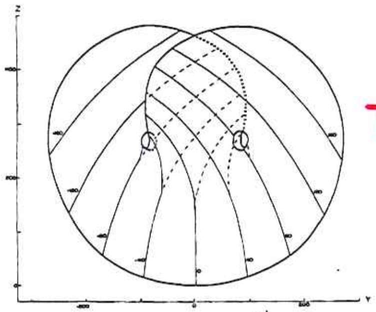
$$\begin{cases} \mu \dot{u} = E_a - Ri_a(u) - \left(1 + \dfrac{R}{\beta r}\right) u + (1-\beta)\dfrac{R}{\beta r} z - v_1 \\ \dot{v}_1 = z \\ \dot{z} = \dfrac{C_1}{\beta(1-\beta)C_2} u - \left(1 + \dfrac{C_1}{\beta C_2}\right) \dfrac{z}{1-\beta} \end{cases}$$



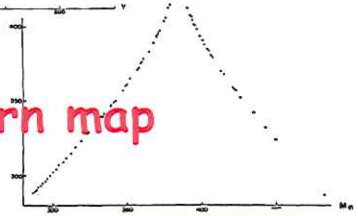
Lorenz 1963



Phase portrait



Topology



First-return map

PERIOD THREE IMPLIES CHAOS

TIEN-YIEN LI AND JAMES A. YORKE

THEOREM 1. *Let J be an interval and let $F: J \to J$ be continuous. which the points $b = F(a)$, $c = F^2(a)$ and $d = F^3(a)$, satisfy*

$$d \leqq a < b < c \text{ (or } d \geqq a > b > c).$$

Then

T1: *for every $k = 1, 2, \cdots$ there is a periodic point in J havin*

Furthermore,

T2: *there is an uncountable set $S \subset J$ (containing no periodic the following conditions:*

(A) *For every $p, q \in S$ with $p \neq q$,*

(2.1) $$\limsup_{n\to\infty} |F^n(p) - F^n(q)| > 0$$

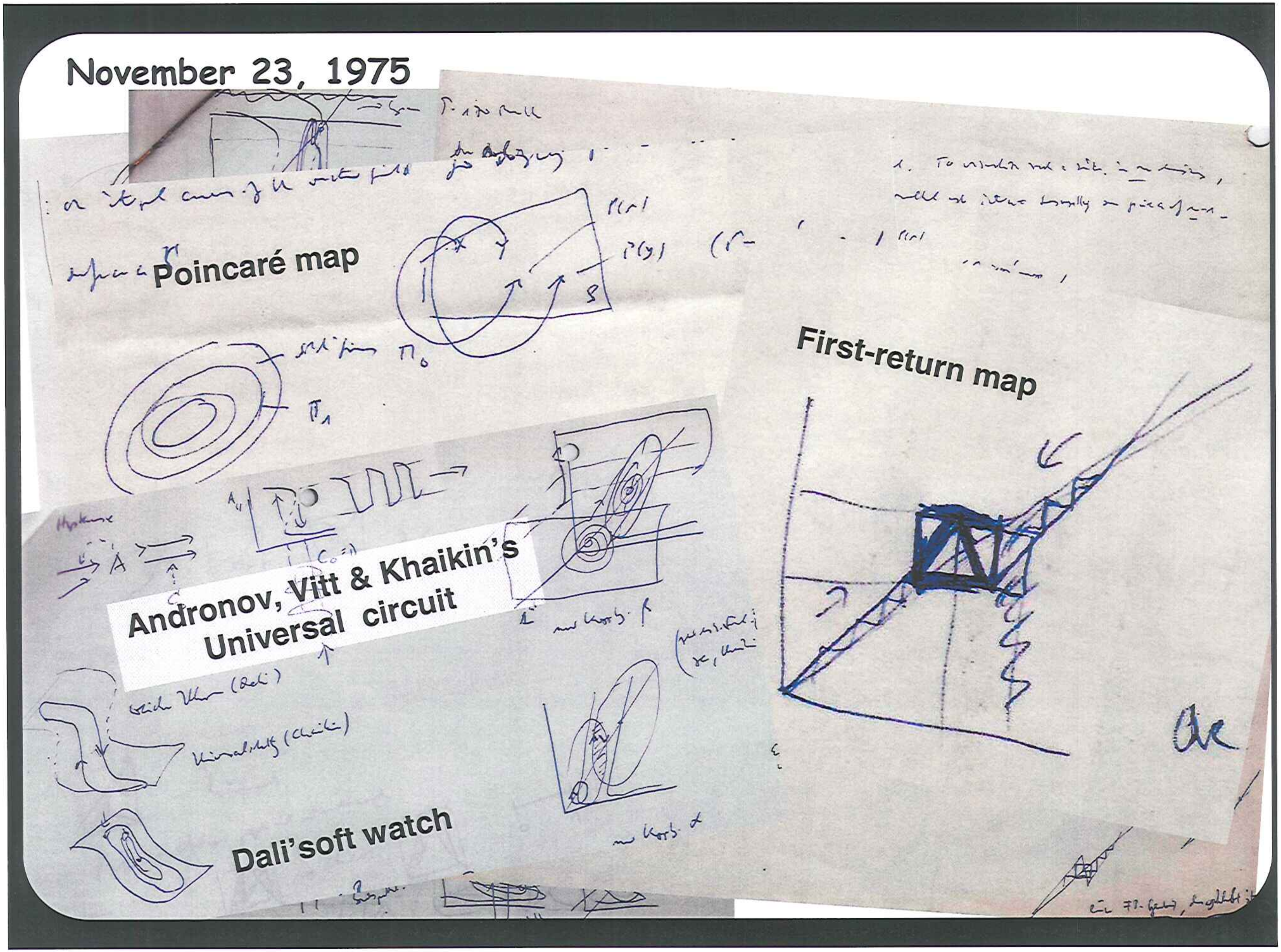
and

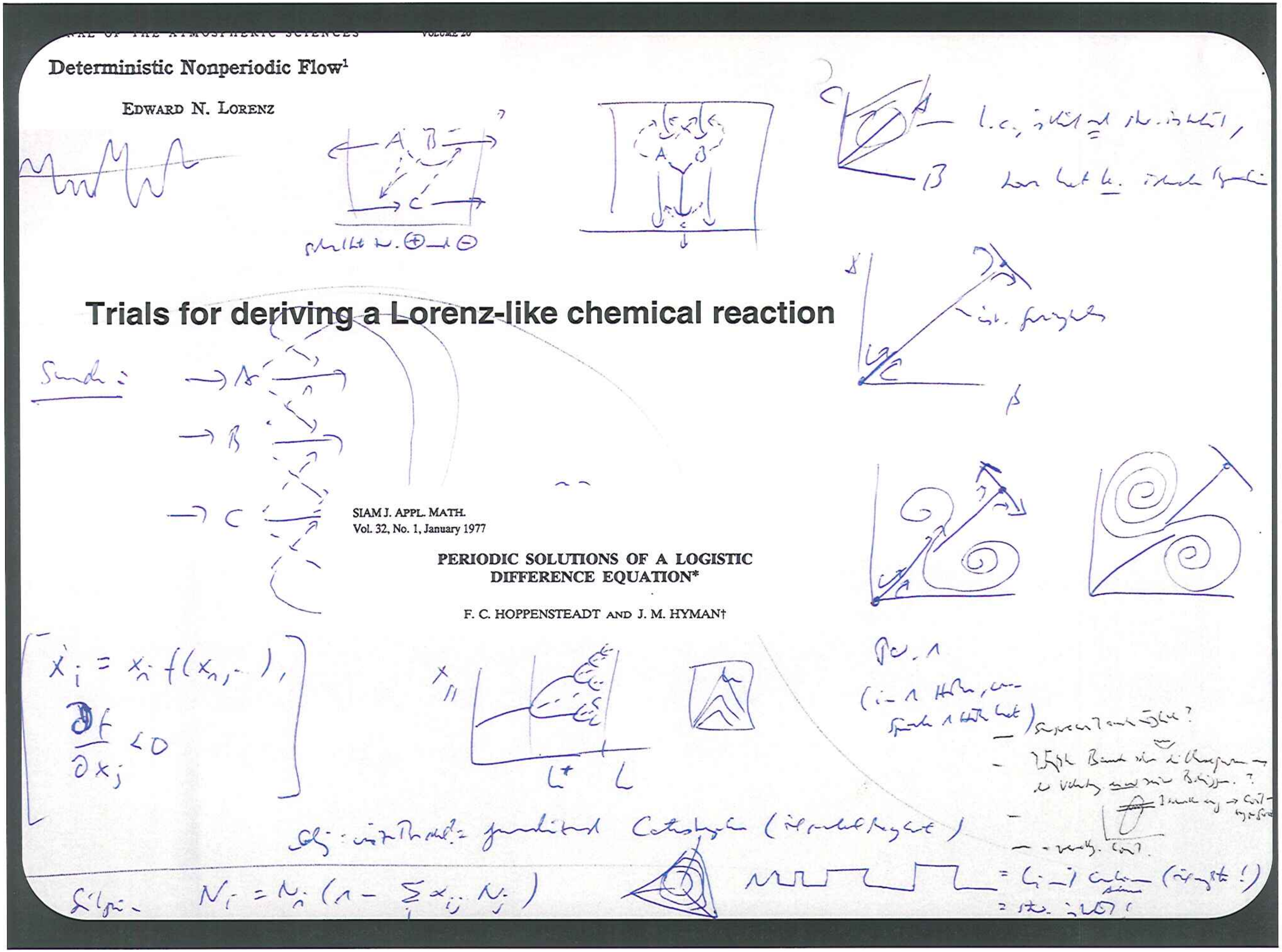
(2.2) $$\liminf_{n\to\infty} |F^n(p) - F^n(q)| = 0.$$

(B) *For every $p \in S$ and periodic point $q \in J$,*

$$\limsup_{n\to\infty} |F^n(p) - F^n(q)| > 0.$$

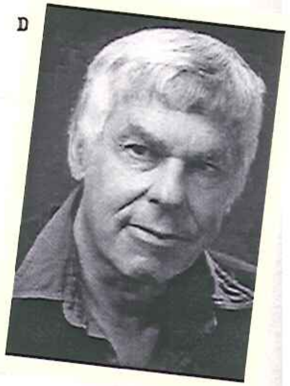
REMARKS. Notice that if there is a periodic point with period 3, th will be satisfied.


November 23, 1975
Poincaré map
First-return map
Andronov, Vitt & Khaikin's
Universal circuit
Dali'soft watch


Deterministic Nonperiodic Flow[1]
Edward N. Lorenz
Trials for deriving a Lorenz-like chemical reaction
SIAM J. Appl. Math.
Vol. 32, No. 1, January 1977
PERIODIC SOLUTIONS OF A LOGISTIC DIFFERENCE EQUATION*
F. C. Hoppensteadt and J. M. Hyman†

December 11, 1975

D

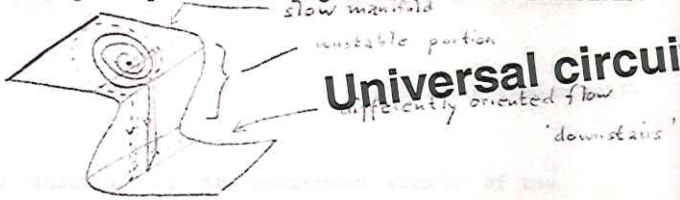


Professor
Steve Smale
Department of Mathematics
University of California
Berkeley, Calif. 94720
U.S.A.

Dear Dr. Smale:

Two different picturesque points that I thought might interest you together make a suprathreshold reason for actually writing you a letter.

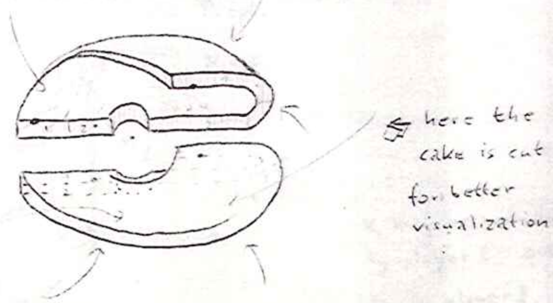
i) A 'reinjection' principle for chaos generation in 3 dimensions.



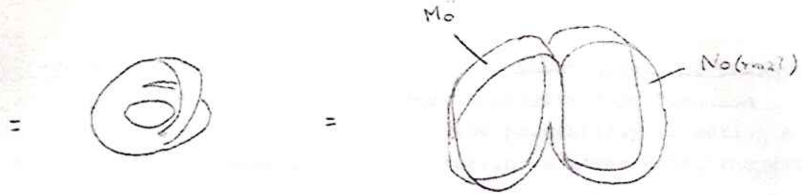
Universal circuit

The corresponding simple "three-dimensional mincer":

Topology



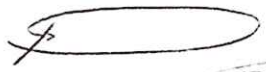
The corresponding topologiѕal prototype, stretched flat:



Topology

Conjecture: Just as <u>recurrence</u> (of trajectories) makes limit cycles possible after going from one to two dimensions, so <u>reinjection</u> (of a bundle) makes such a pouch-type attractor possible after the transition from 2 to 3 dimensions.

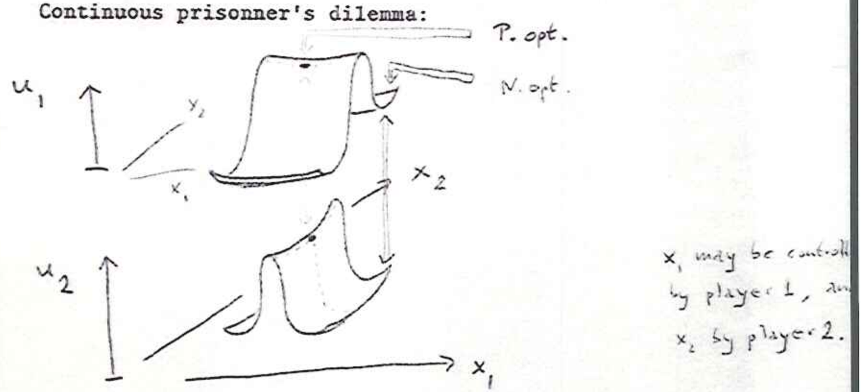
1d.: 

2d.: 

3d.:  (containing random coil).

ii) A proposed "solution" for the continuous version of the prisonner's dilemma.

Continuous prisonner's dilemma:



The only Pareto optimum (Par.opt.) id much less advantageous to both players than one of the 4 non-optima (N.opt.).

December 1st, 1975

Text starts new line; indent 3

START TYPING AT ARROW. SEE SA

CHAOS IN SIMPLE REACTION SYSTE
O.E. Rössler, Division of Theoretical C
Following E.N. Lorenz's (1) determir
ence, the same sort of behavior can be
reaction systems. The simplest working
'pouch' out of a slow manifold, such t
cliff; see (2)) and then 're-injected'
itions of the Li-Yorke theorem (3), pr
a Poincaré map. One possible set of ra

$$\dot{x} = ax - by\frac{x}{x+K} + ez$$
$$\dot{y} = cx - dy$$
$$\dot{z} = \mu(1 + fz - gz^2 - hx\frac{z}{z+K'}$$

The system, a 'universal circuit' in
more 'universal' than originally tho
from a 3-component, modified Lotka-V
I thank Art Winfree for literatu

(1). E.N. Lorenz, J. Atmos. Sci. 2
(2). E.C. Zeeman, in: Towards a Th
(3). T.Y. Li and J.A. Yorke, SIAM
(4). S.E. Khaikin, Zh. Prikl. Fiz.

(Member) Spo

UNIVERSITY of PENNSYL
PHILADELPHIA 19174

The College
DEPARTMENT OF BIOLOGY G5

PS9, 4

January 7, 1976

Dr. Otto E. Rössler
Privatdozent of Theoretical Biochemistry
der Universitat Tubingen
7400 Tubingen
West Germany

Dear Dr. Rössler:

I am sorry to inform you that your abstract for the B
meeting arrived here on December 10, 1975, too long after
November 15 to be included in the program. In order to me
lines to assure that the abstract booklet would be availab
sufficiently in advance of the meeting, the Program Committ
its job very quickly and the abstracts were delivered to th
November 19.

I am returning your abstract with this letter.

Sincerely,

Lee D. Peachey

Lee D. Peachey
1976 Biophysical Soci
Program Chairman

LDP/sr
Encl.

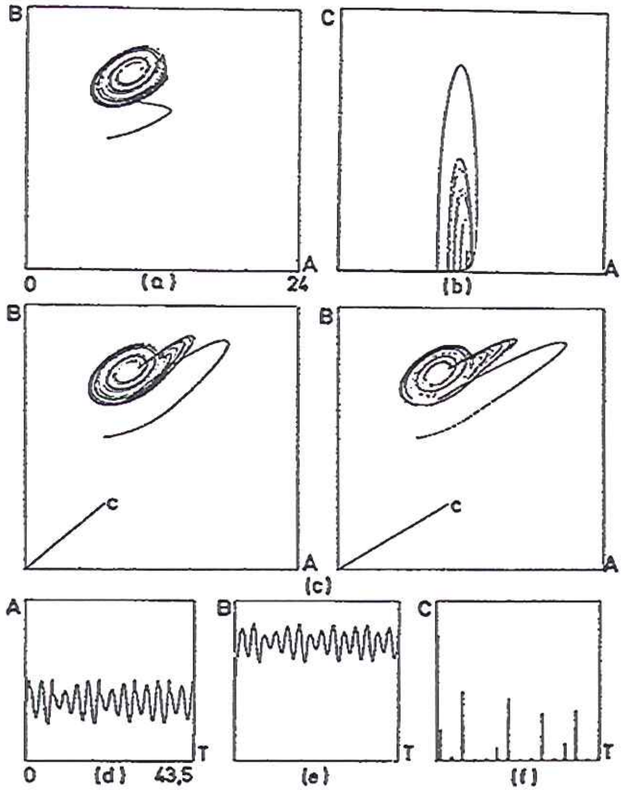
Chaotic Behavior in Simple Reaction Systems

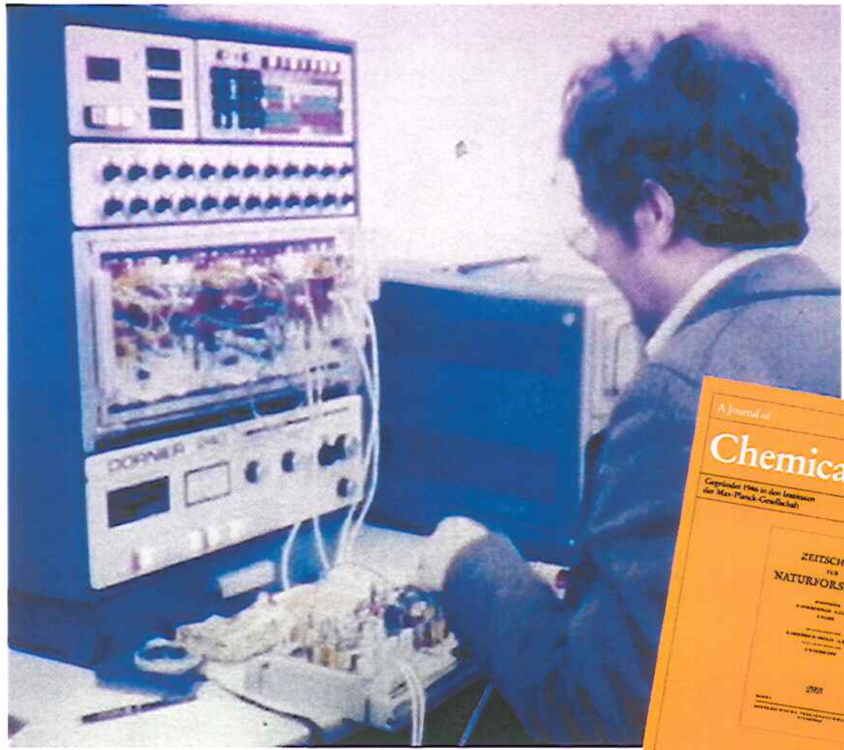
Otto E. Rössler

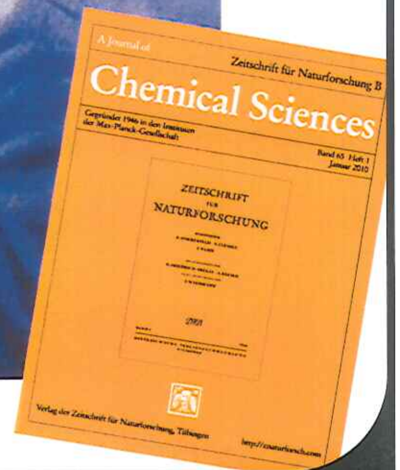
Institut für Physikalische und Theoretische Chemie der Universität Tübingen

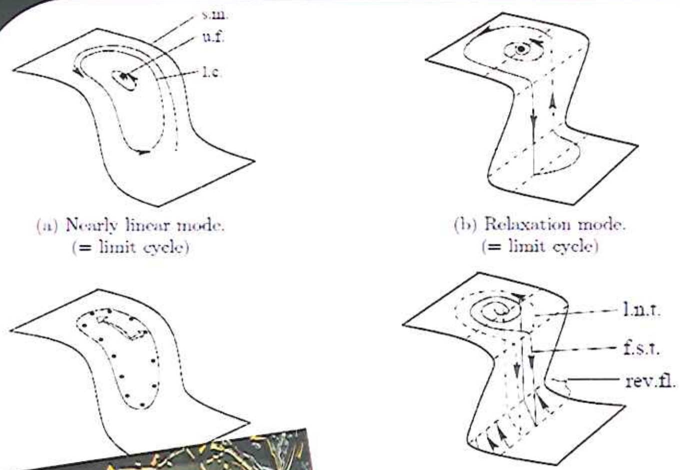
(Z. Naturforsch. 31 a, 259—264 [1976]; received January 5, 1976)

Chemical system theory, exotic kinetics, nonperiodic oscillation, 3-variable dynamical systems, strange attractors







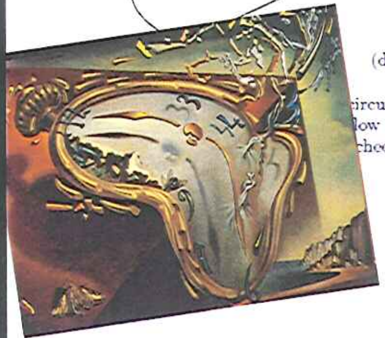


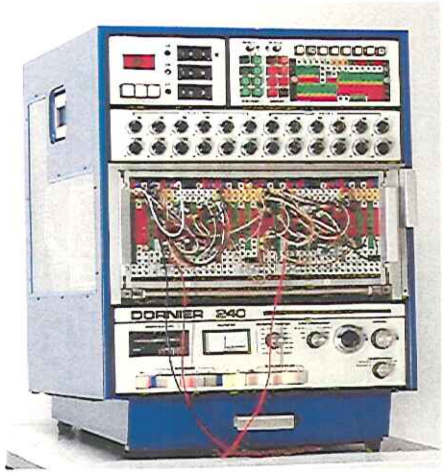
(a) Nearly linear mode. (= limit cycle)

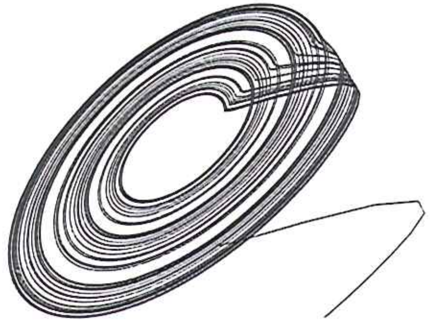
(b) Relaxation mode. (= limit cycle)

(d) Chaos-producing mode (see text).

circuit. s.m.= slow manifold, u.f.= unstable
low manifold in (b) and (d) is unstable, f.s.t.
ched trajectory", rev.fl.= reversed direction

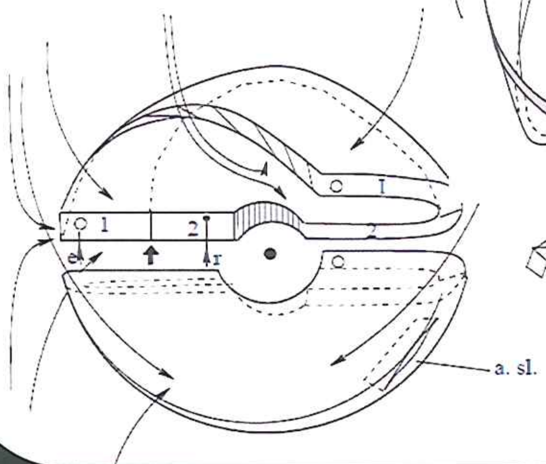


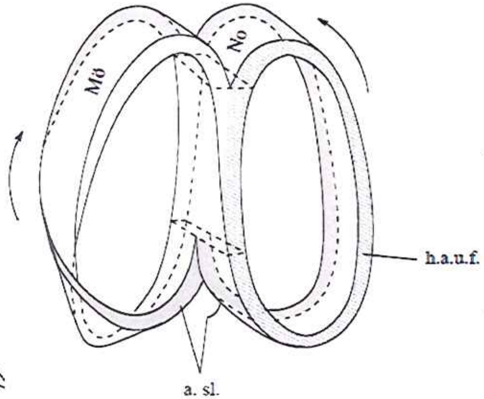


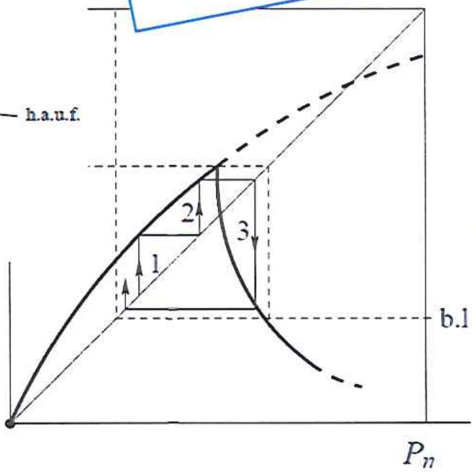


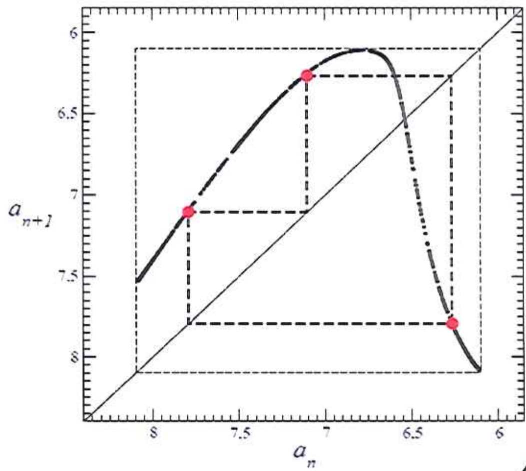
$$\begin{cases} \dot{a} &= k_1 + k_2 a - \dfrac{(k_3 b + k_4 c)a}{a+K} \\ \dot{b} &= k_5 a - k_6 b \\ \mu\dot{c} &= k_7 a + k_8 c - k_9 c^2 - \dfrac{k_{10} c}{c+K'} \end{cases}$$

PERIOD THREE IMPLIES CHAOS

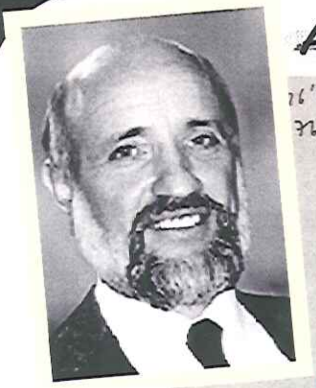


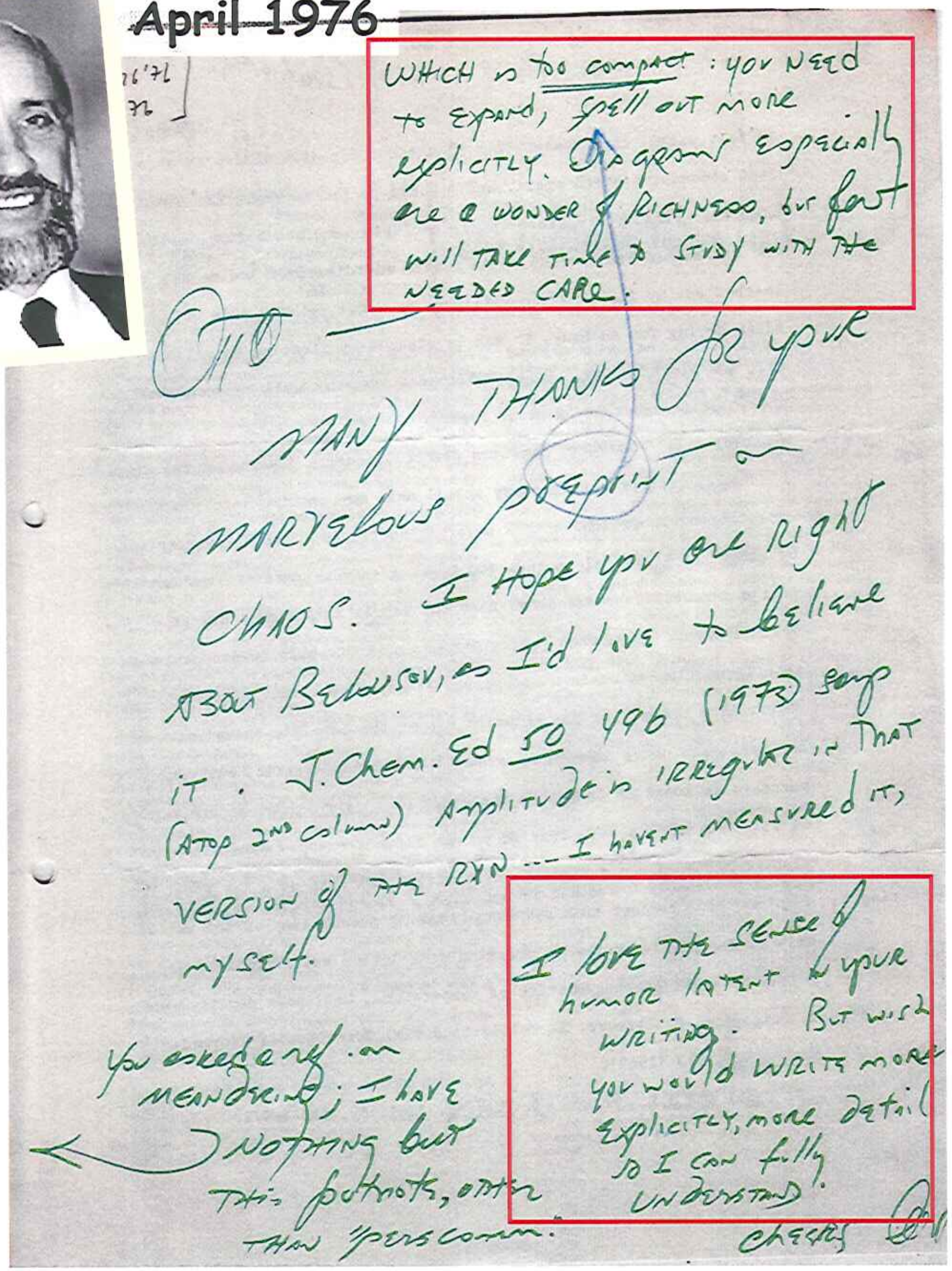






April 1976





WHICH IS TO COMPACT: YOU NEED TO EXPAND, SPELL OUT MORE EXPLICITLY. DIAGRAMS ESPECIALLY ARE A WONDER OF RICHNESS, BUT FAR WILL TAKE TIME TO STUDY WITH THE NEEDED CARE.

OTTO — MANY THANKS FOR YOUR MARVELOUS PREPRINT ON CHAOS. I HOPE YOU ARE RIGHT ABOUT BELOUSOV, AS I'D LOVE TO BELIEVE IT. J. CHEM. ED 50 496 (1973) SAYS (ATOP 2ND COLUMN) AMPLITUDE IS IRREGULAR IN THAT VERSION OF THE RXN.... I HAVEN'T MEASURED IT, MYSELF.

I LOVE THE SENSE OF HUMOR LATENT IN YOUR WRITING. BUT WISH YOU WOULD WRITE MORE EXPLICITLY, MORE DETAIL, SO I CAN FULLY UNDERSTAND.

YOU ASKED A REF. ON MEANDERING; I HAVE NOTHING BUT THIS FOOTNOTE, OTHER THAN "PERS COMM."

CHEERS

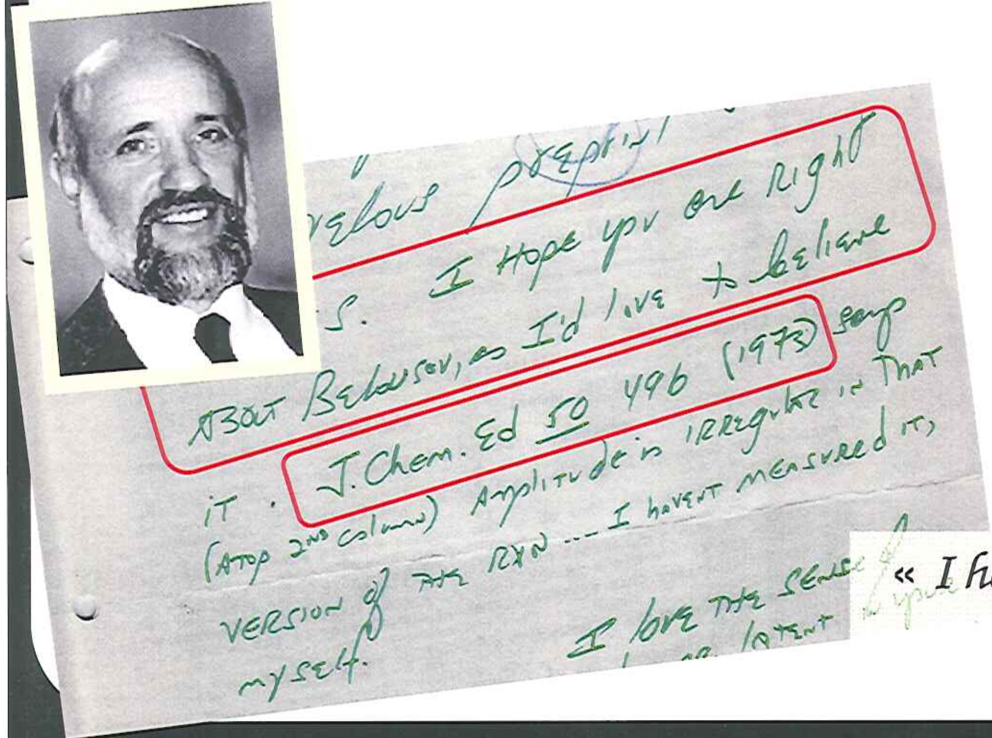
« which is to compact: you need to expand, spell out more explicitly. Diagrams especially are a wonder of richness, but far will take time to study with the needed care. »

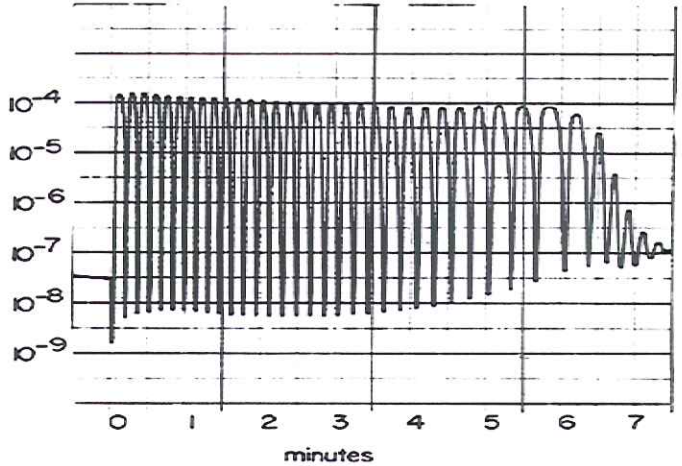
« I love the sense of humour latent in your writing. But wish you would write more explictly, more detail, so I can fully understand.»

Thomas S. Briggs
and **Warren C. Rauscher**
Galileo High School Lux Laboratory
1150 Francisco Street
San Francisco, California 94109

An Oscillating Iodine Clock

« We have found an oscillating iodine clock reaction that gives striking cyclic changes from colorless to gold to blue using simple reagents.[…] Many variations of this reaction exist. We have observed short-lived oscillations by substituting 2,4-pentanedione for malonic acid. Cerium mav he used in place of manganese and gives higher frequency oscillations of variable Amplitude. »


velous preprint
S. I hope you are right
about Belousov, as I'd love to believe
it. J. Chem. Ed 50 496 (1973) says
(atop 2nd column) Amplitude is irregular in that
version of the rxn ... I haven't measured it
myself.
I love the sense

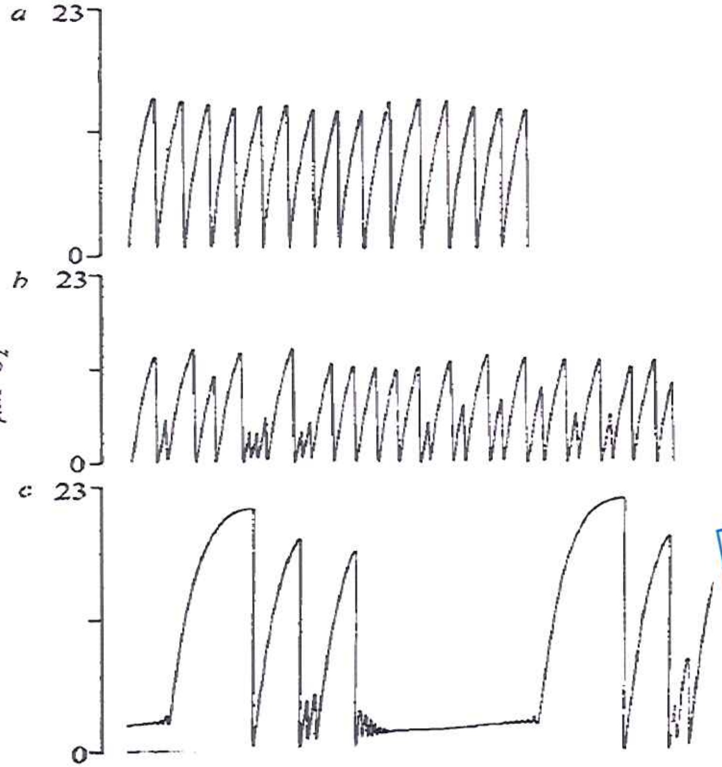


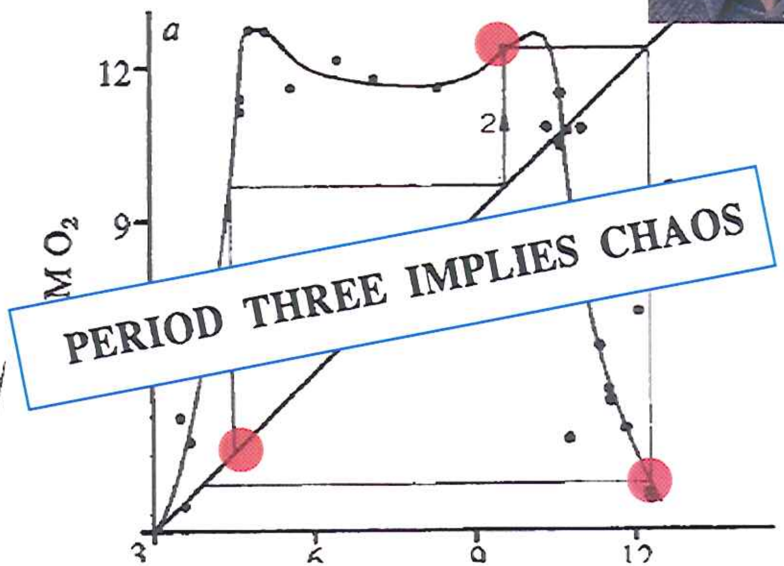
« I hope you are right about Belousov, as I'd love to believe it. »

Chaos in an enzyme reaction

LARS FOLKE OLSEN
HANS DEGN

Institute of Biochemistry,
Odense University,
Odense, Denmark





solutions. The argument is based on a theorem by Li and Yorke[3]. Here we report the finding of chaotic behaviour as an experimental result in an enzyme system (peroxidase). Like Rössler[2] we base our identification of chaos on the theorem by Li and Yorke[3].

Nature Vol. 267 12 May 1977

Lars Folke Olsen

INSTITUTE OG BIOCHEMISTRY
ODENSE UNIVERSITET
NIELS BOHRS ALLE . 5000 ODENSE
TLF. (09) 13 66 00 . POSTGIRO 2010755

Dr. O.E. Rössler
Lehrstuhl für Theoretische
Chemie der Universität
Tübingen
D-7400 Tübingen
W. Germany

J. nr.
(bedes anført ved henvendelse om denne sag)
Bilag:
Dato 75.12.04

"I first met Otto Rössler at a conference in Vienna, Austria in September 1975. [...] I was deeply fascinated with the man and his enthusiasm in the science he was presenting. [...]

A few months later I was awarded a travel grant from the University (Odense University) to spend 4-6 weeks in a foreign laboratory and, although I had many offers from well-reputed laboratories in Europe, there was no doubt in my mind that my number one priority was to visit Otto in Tübingen, and so I did in January-February 1976. Those weeks were some of the most exciting weeks in my scientific life and I had no idea that they would shape my remaining scientific career.

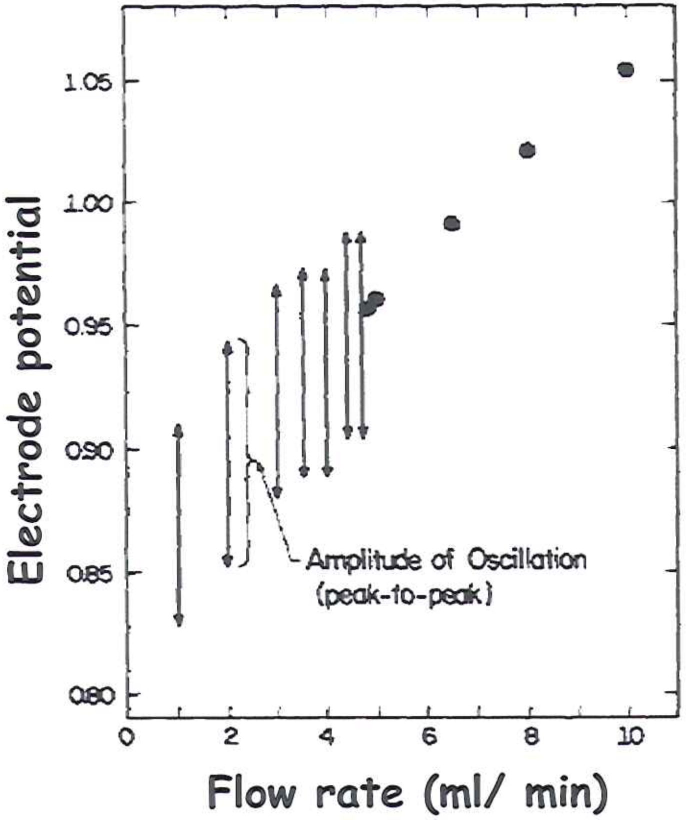
Best regards,

Hans Degn

The Chemical Engineering Journal, *12* (1976) 9–21

The Belousov–Zhabotinskii Reaction in

K. R. GRAZIANI*, J. L. HUDSON** and R.



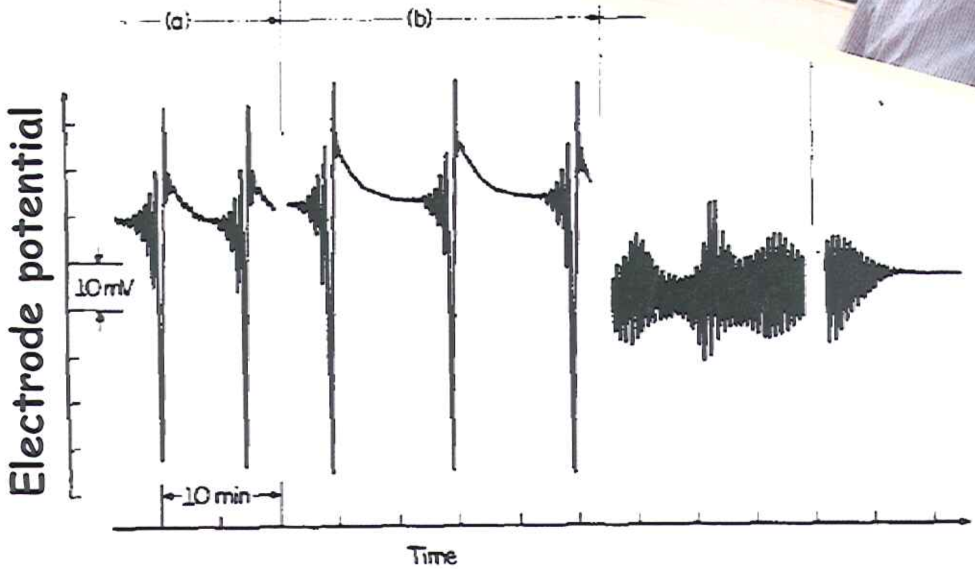


Fig. 3. Effect of sodium bromate feed rate on oscillations: (a) 1.28 ml min^{-1}; (b) 1.32 ml min^{-1}, the normal flow rate of bromate for a total flow of 4.7 ml min^{-1}; (c) 1.33 ml min^{-1}; (d) 1.36 ml min^{-1}.

Peak-to-peak fluctuations for sustained oscillations

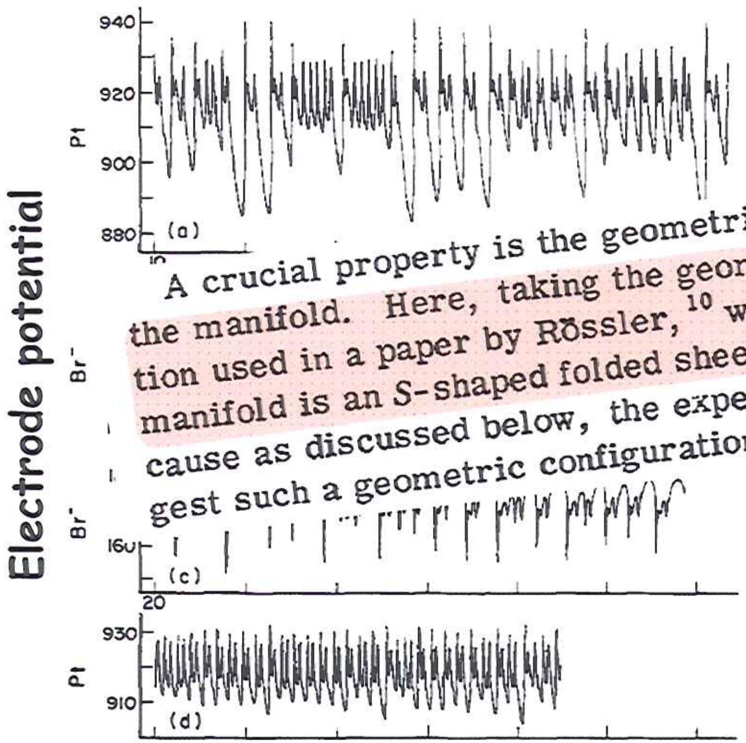
1977

Experimental evidence of chaotic states in the Belousov–Zhabotinskii reaction

R. A. Schmitz, K. R. Graziani,[a] and J. L. Hudson[b]

Department of Chemical Engineering, University of Illinois, Urbana, Illinois 61801
(Received 3 May 1977)

Experimental results are reported which show strong evidence that the Belousov–Zhabotinskii reaction proceeds in an intrinsic chaotic (sustained time-dependent, nonperiodic) manner over a range of residence



A crucial property is the geometric configuration of the manifold. Here, taking the geometric representation used in a paper by Rössler,[10] we suppose that the manifold is an S-shaped folded sheet (see Fig. 4), because as discussed below, the experimental results suggest such a geometric configuration.

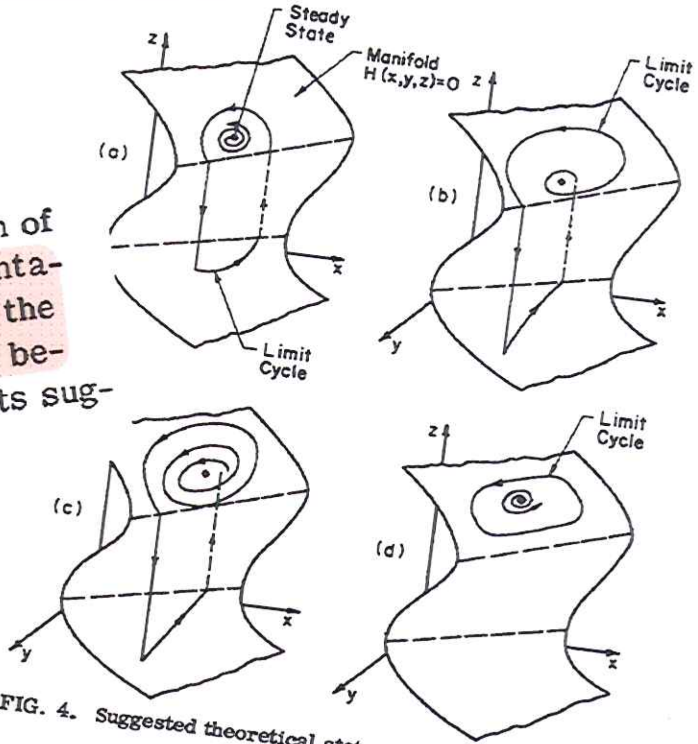


FIG. 4. Suggested theoretical state space trajectories.

1978

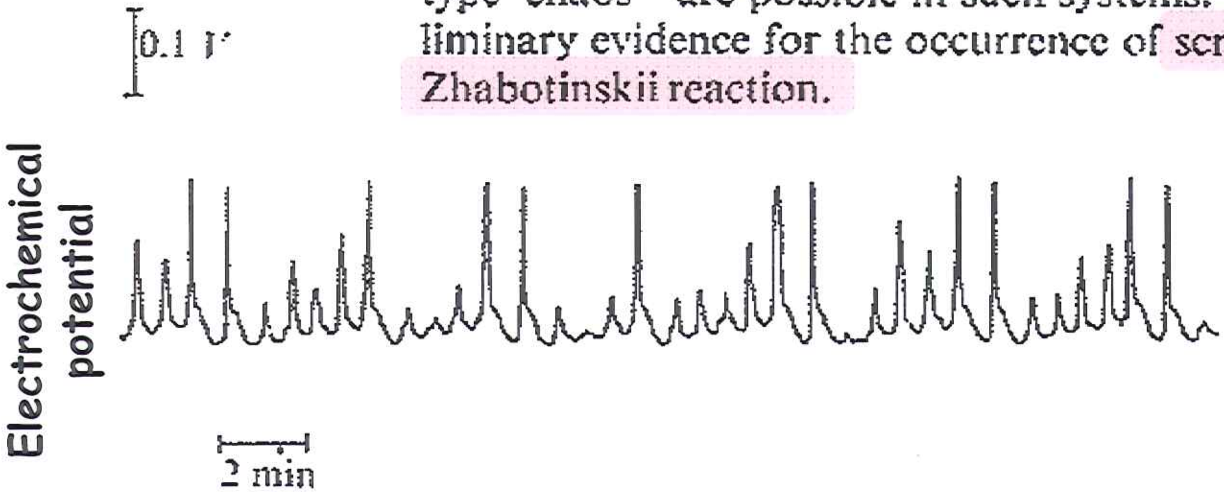
OTTO E. ROSSLER
sical and Theoretical Chemistry,
bingen,
Theoretical Physics,
ttgart

KLAUS WEGMANN
mical Plant Physiology,
bingen, 7400 Tübingen, FRG

Chaos in the Zhabotinskii reaction

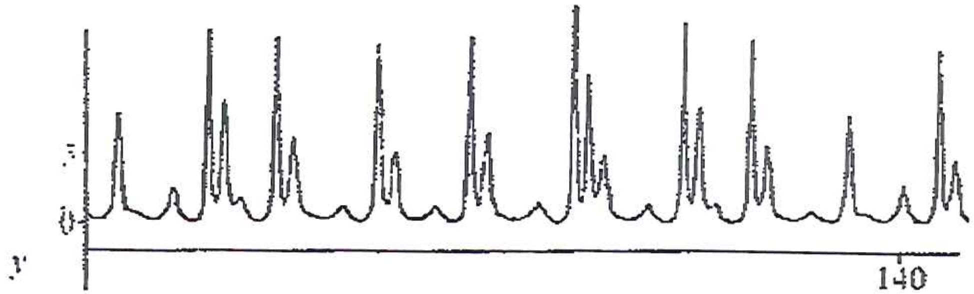
THE Belousov–Zhabotinskii reaction is a chemical Bonhoeffer–van der Pol circuit, that is, a relaxation oscillator that can be run as both an astable and a monostable 'flip-flop'[1–3]. Apparently

type' chaos[20] are possible in such systems. We present here preliminary evidence for the occurrence of screw-type chaos in the Zhabotinskii reaction.



compared to

$$\begin{cases}\dot{x} = -y - z \\ \dot{y} = x + 0.55y \\ \dot{z} = 2 - 4z + xz\end{cases}$$



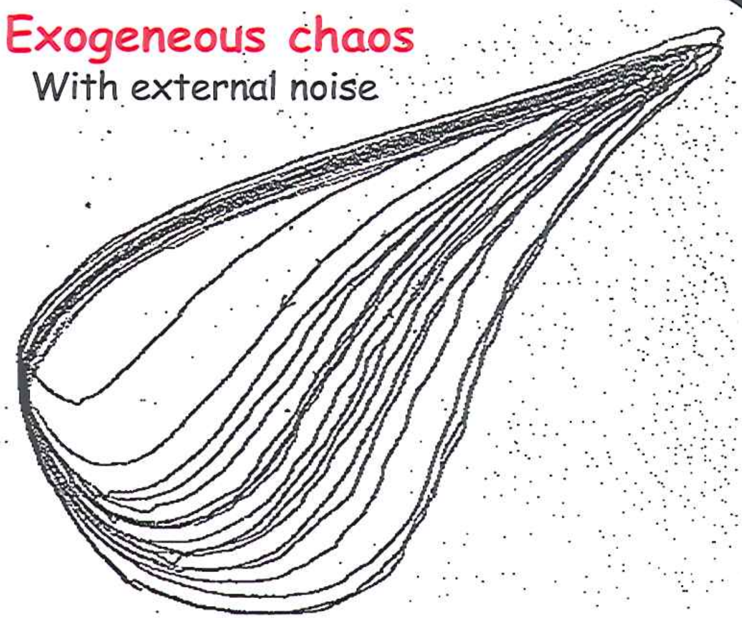
Different Kinds of Chaotic Oscillations in the Belousov-Zhabotinskii Reaction

Klaus Wegmann
Institut für Chemische Pflanzenphysiologie der Universität

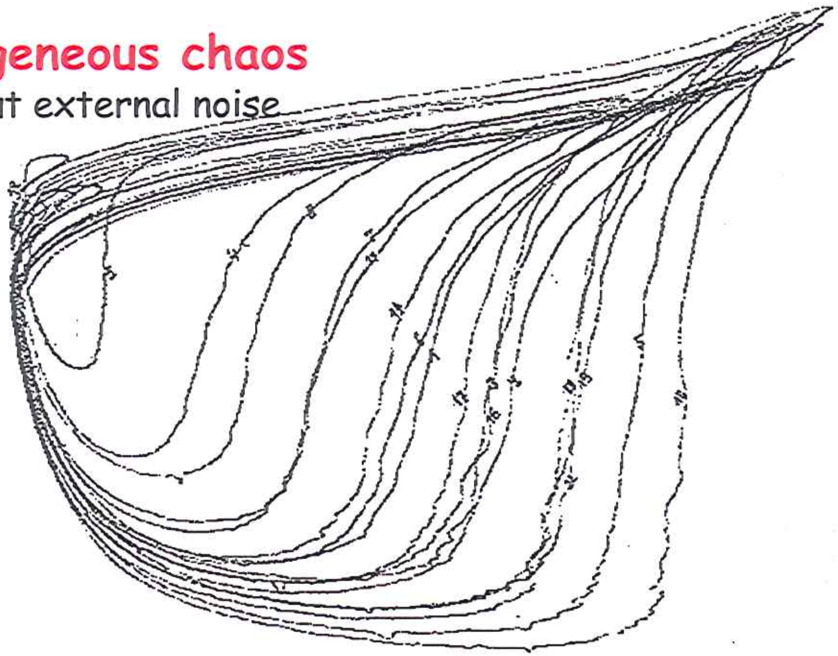
and

Otto E. Rössler
Institut für Physikalische und Theoretische Chemie der Ur
Institut für Theoretische Physik der Universität Stuttgart

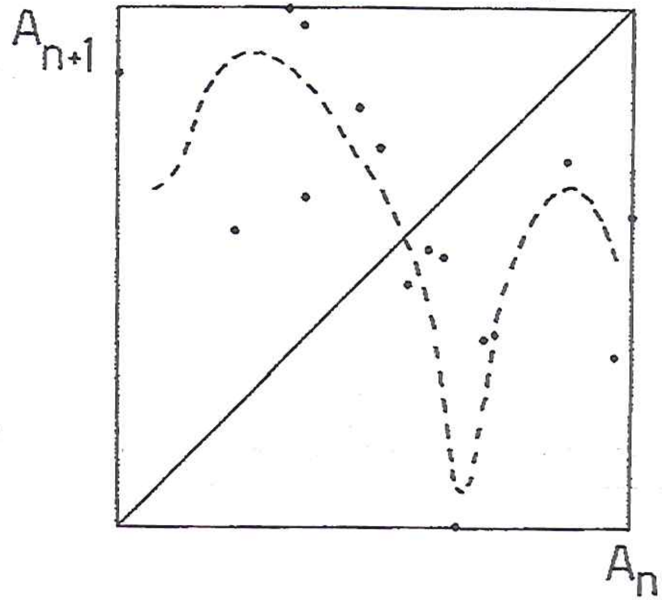
Exogeneous chaos
With external noise



Endogeneous chaos
without external noise



Next-amplitude map



Z. Naturforsch. 33a, 1179—1183 (1978); received July 19, 1978