Física nolineal y smartphones

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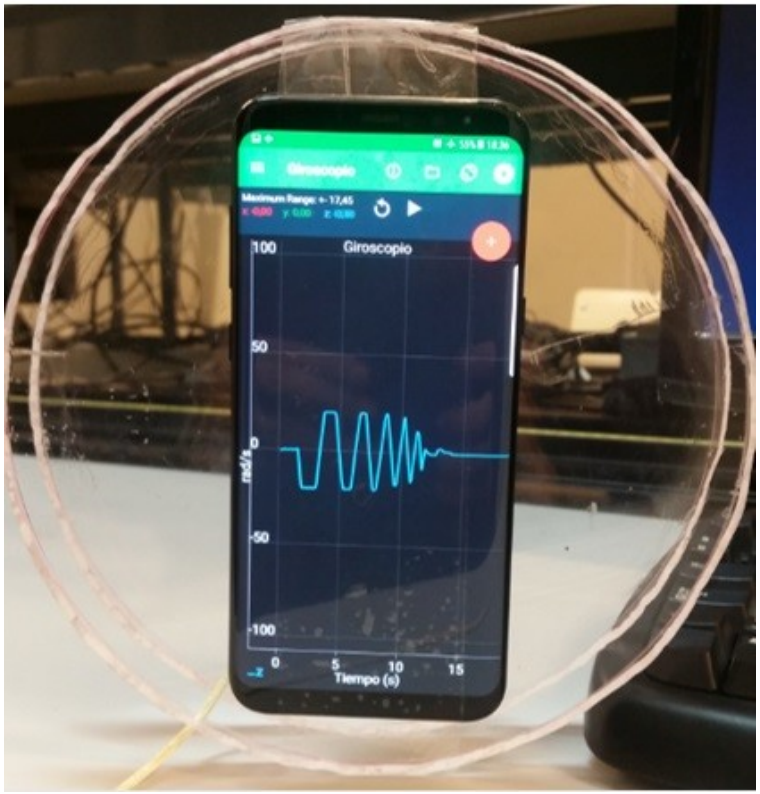
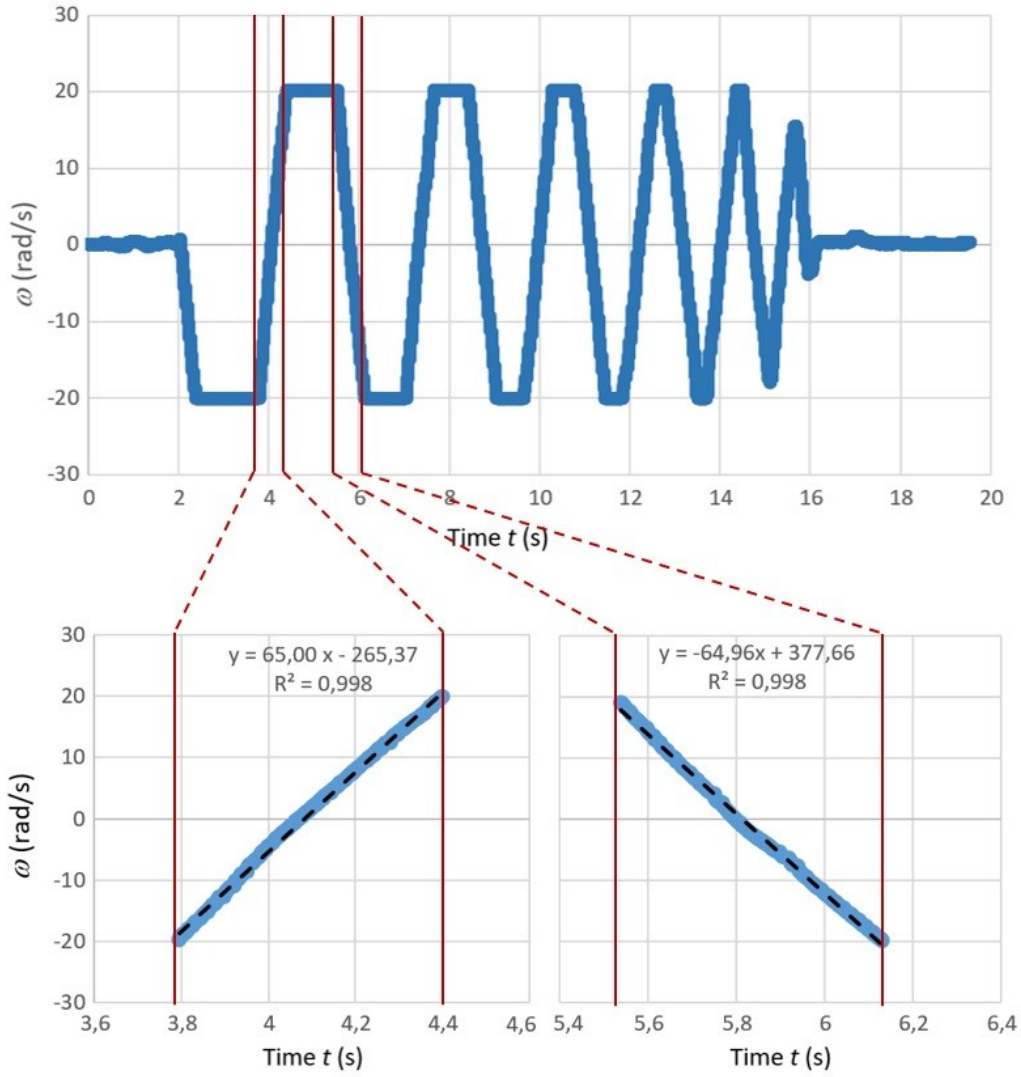
Seminario de Física nolineal,
Junio, 2020

T1: Analyzing the dynamics of a yoyo with a smartphone





Isabel Salinas, MM, AM, Juan A. Monsoriu
Physics Teacher 2020

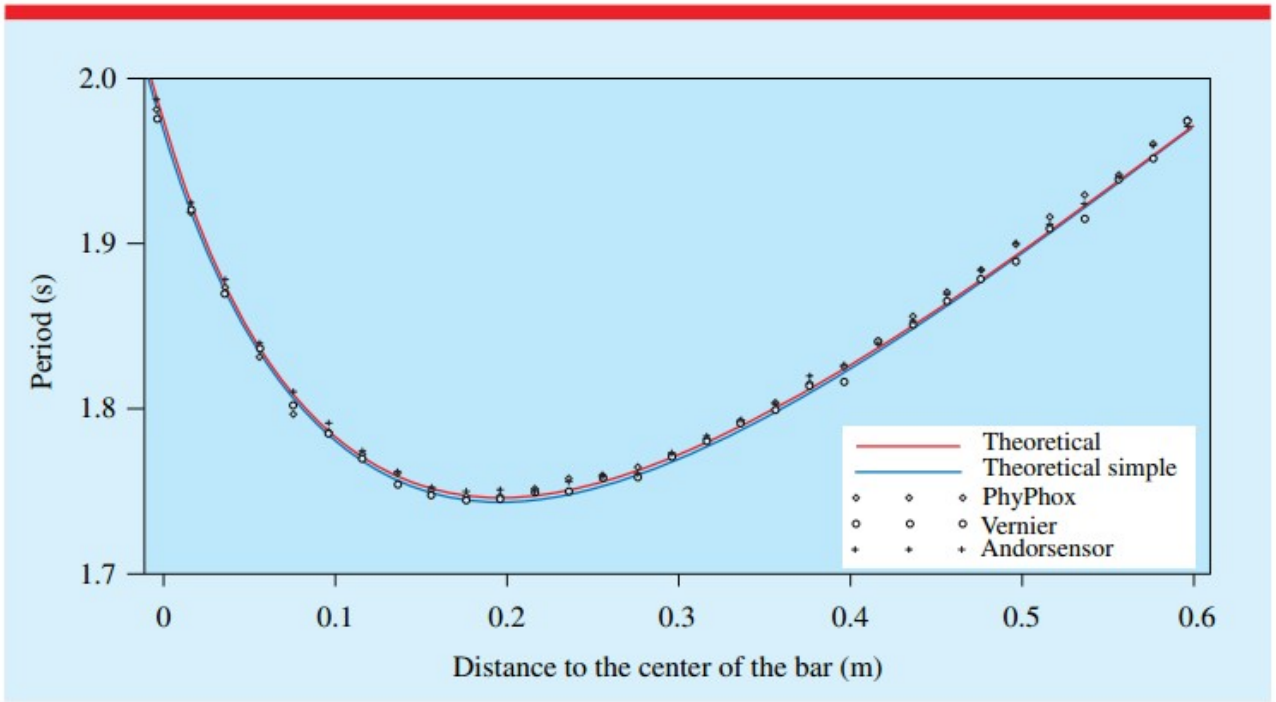
T2: Péndulo físico + smartphone

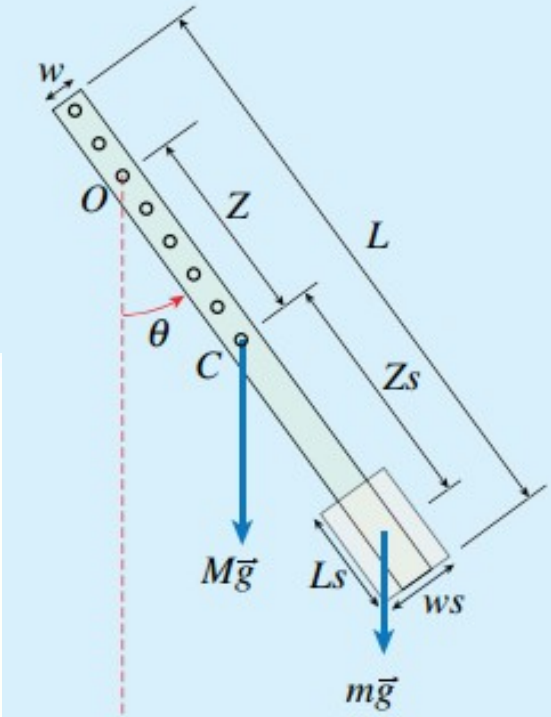
FRONTLINE

Phys. Educ. **55** (2020) 023004 (4pp) iopscience.org/ped

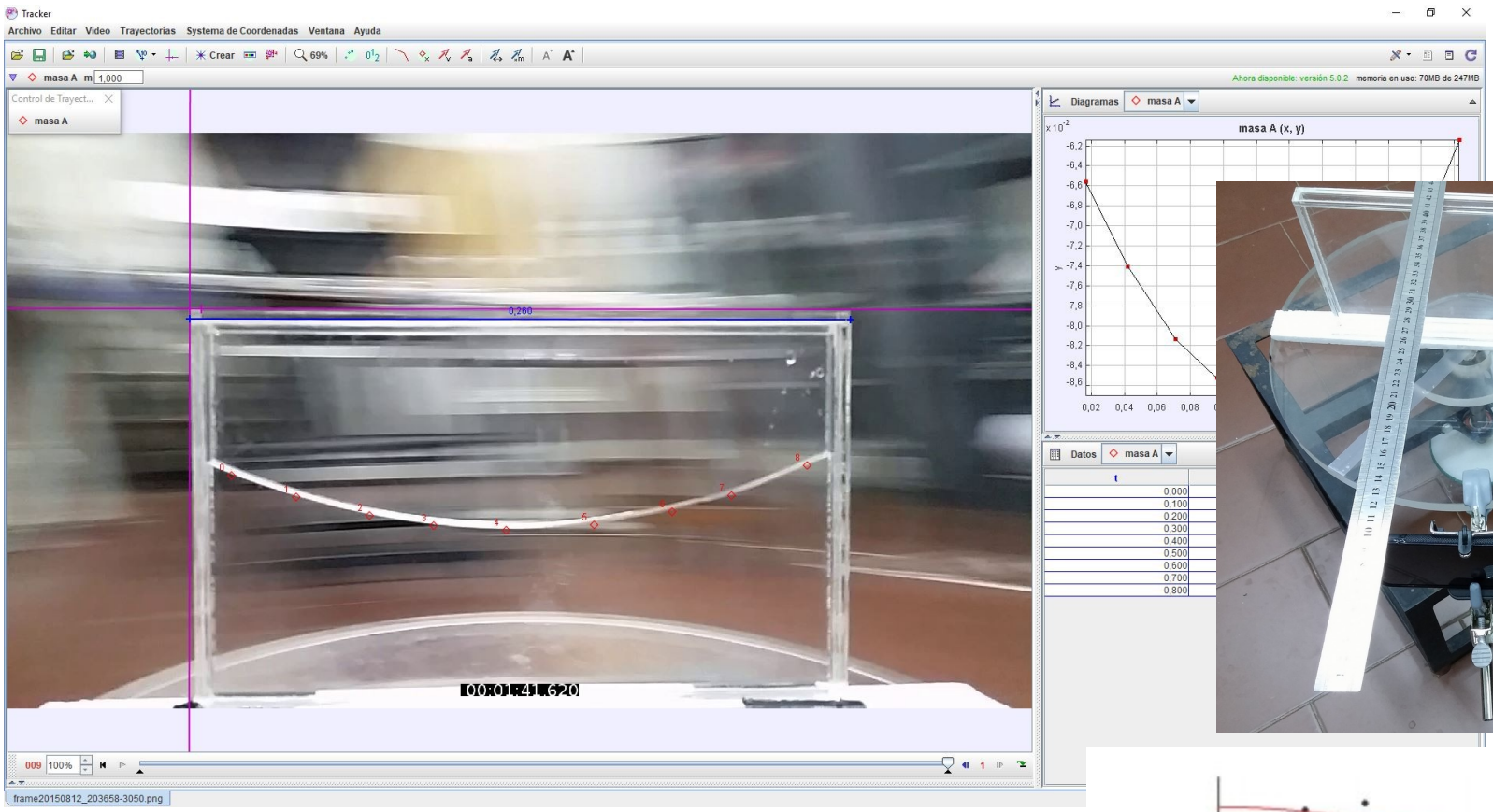
Experimental analysis of a compound pendulum with variable suspension point

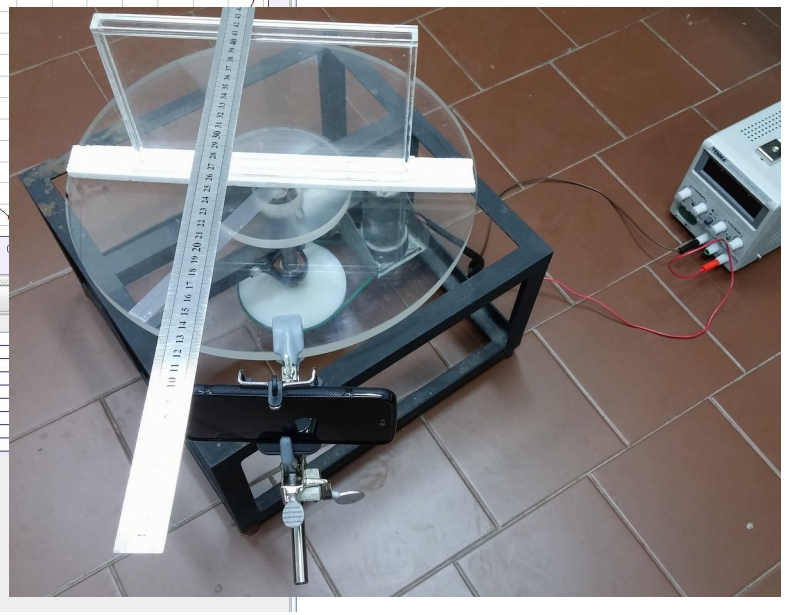
Martín Monteiro[1,2], Cecilia Stari[2], Cecilia Cabeza[2] and Arturo C Martí[2]





T3: Smartphone + fluidos

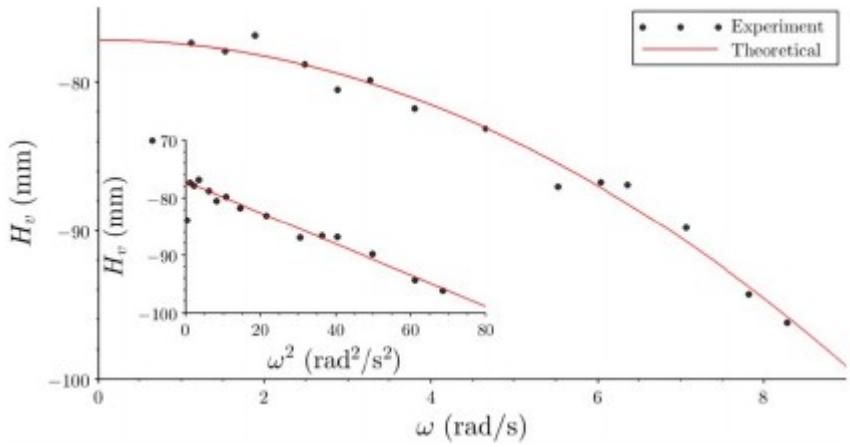




Experimental analysis of the free surface of a liquid in a rotating frame

Martín Monteiro[1,2], Fernando Tornaría[3] and Arturo C Martí[2,4]

Eur. J. Phys. 41 (2020) 035005



T4: Rodar + deslizar + video

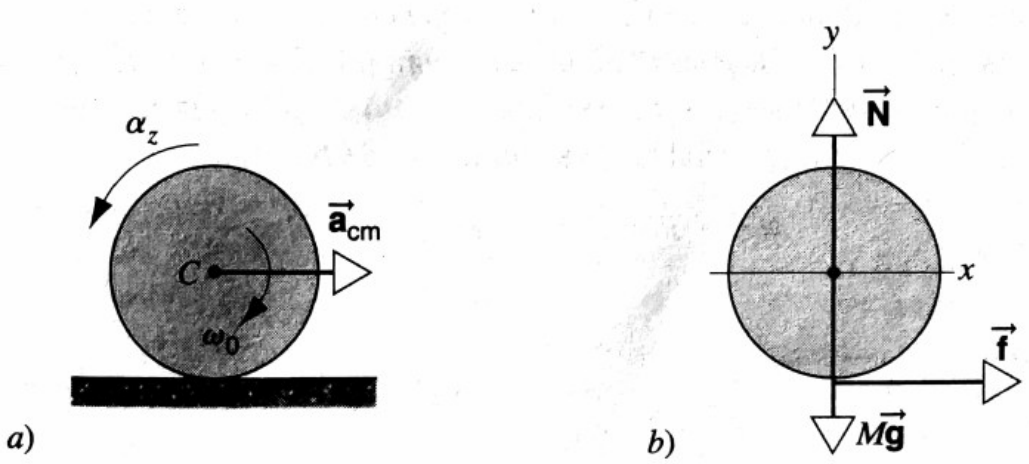
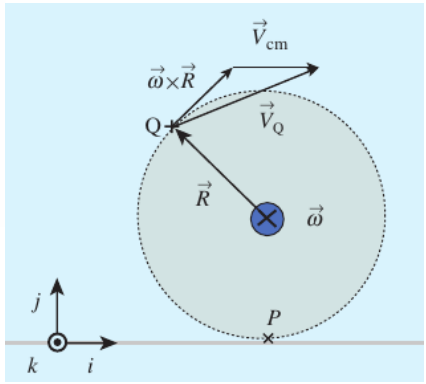
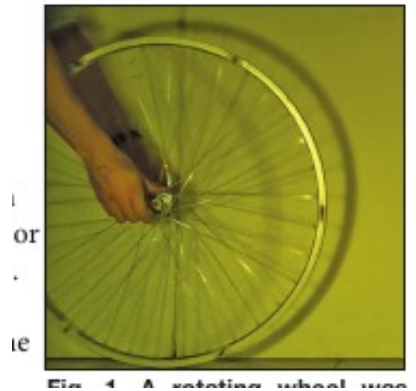


FIGURA 9-33. Problema resuelto 9-12. *a*) El cilindro que gira se desliza inicialmente al rodar. *b*) Diagrama de cuerpo libre del cilindro.

Transición deslizamiento- rodadura
Distribución de velocidades rígido (sistema de lab y relativo)
Coeficiente estático vs dinámico
Fuerza de rozamiento "acelera"





FRONTLINE

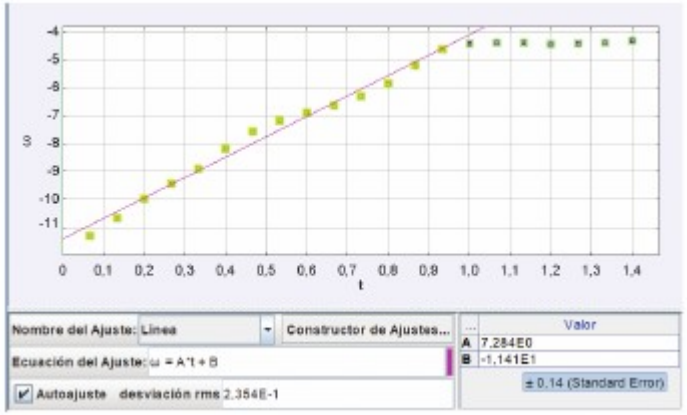
Phys. Educ. **55** (2020) 013002 (5pp) iopscience.org/ped

An experiment to address conceptual difficulties in slipping and rolling problems

Video-Based Analysis of the Transition from Slipping to Rolling

Álvaro Suárez and Daniel Baccino, CFE, Uruguay
Arturo C. Martí, Universidad de la República, Uruguay

Phys. Teach. 58, 170 (2020);



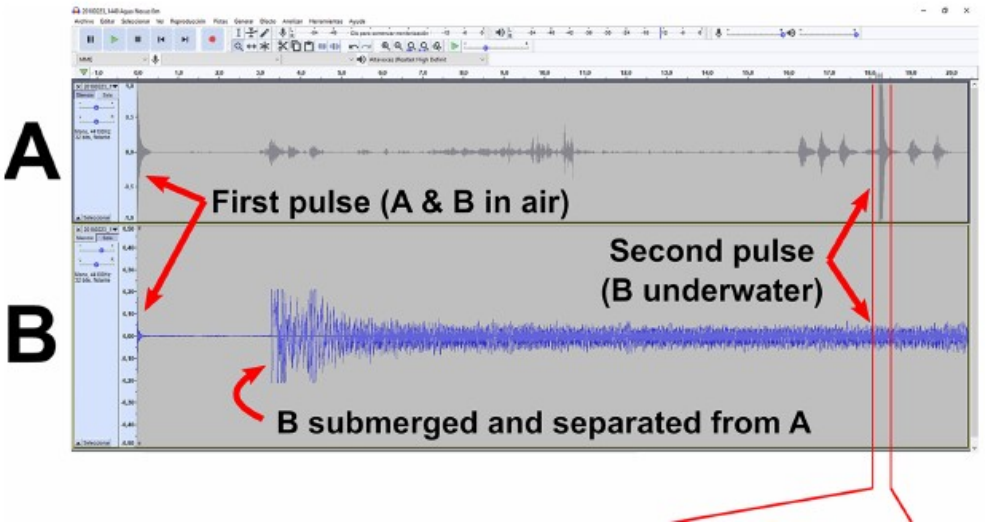
T5: Acústica submarina

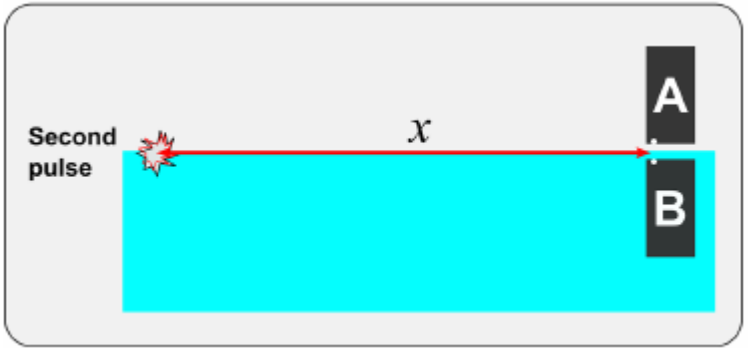
Phys. Educ. **55** (2020) 033013 (4pp)

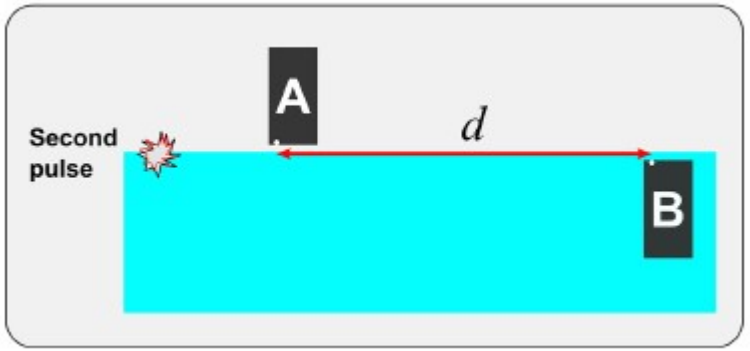
Using smartphones as hydrophones: two experiments in underwater acoustics

Martín Monteiro[1,2] and Arturo C Martí[2]

Medio “extraño” ruidoso
Dificultades para medir





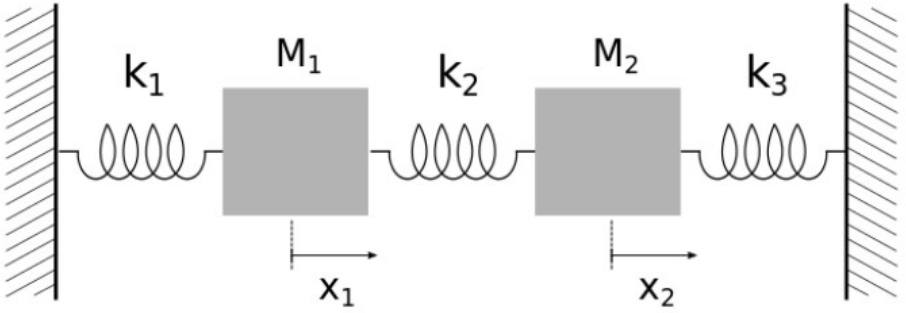


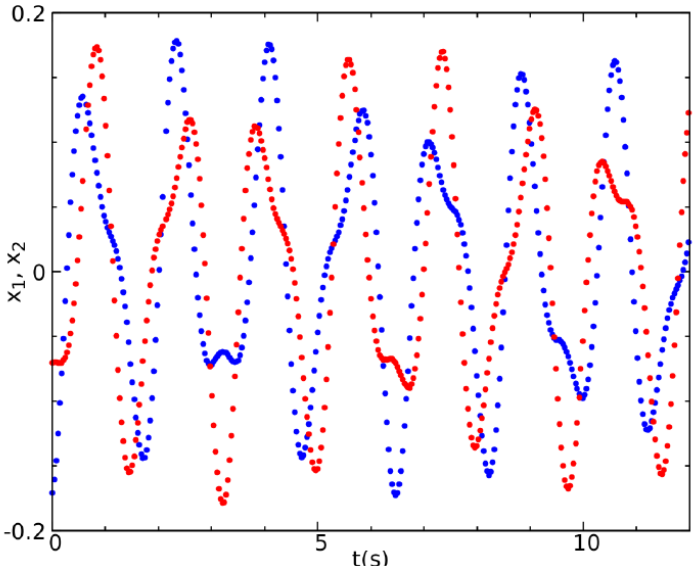
T6: ver *directamente* los modos normales

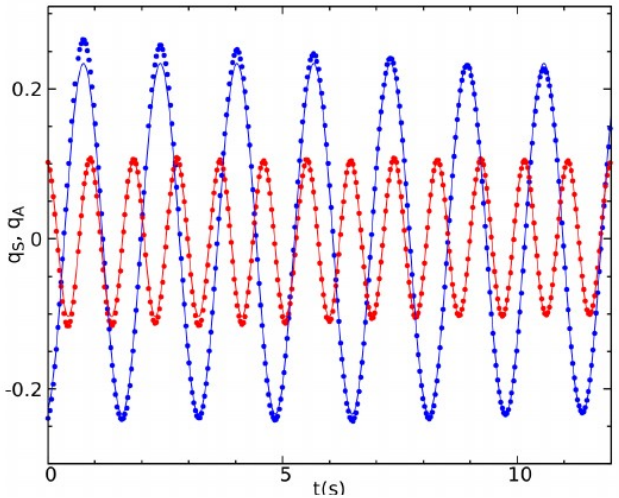
Los modos normales son un *artificio* matemático?

En un sistema oscilando en forma arbitraría cómo podemos *ver* los modos normales?

Cómo influye la masa de los resortes?







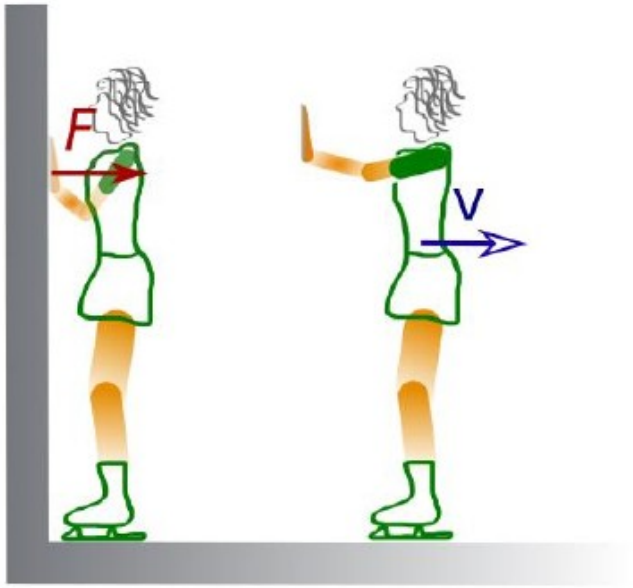
A. Suárez, D. Baccino, MM, AM, enviado 2020

T7: enseñanza de la energía

Los enfoques tradicionales que nos enseñaron sobre energía tienen inconsistencias cuando se toma en cuenta la energía interna

Se vienen publicando artículos hace muchos años

Apenas han repercutido en algunos medios….



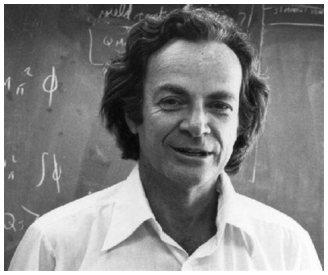
Inconsistencies and errors in traditional approaches to energy in our introductory courses

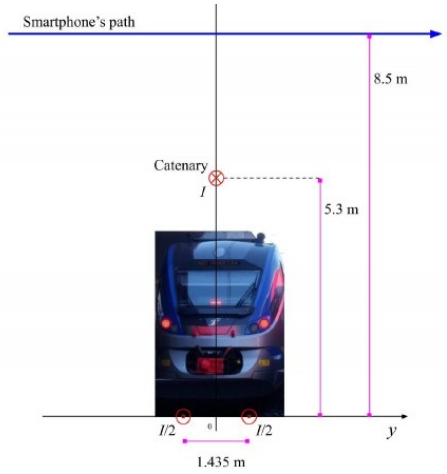
Álvaro Suárez, Daniel Baccino,
Arturo C. Martí, Martín Monteiro

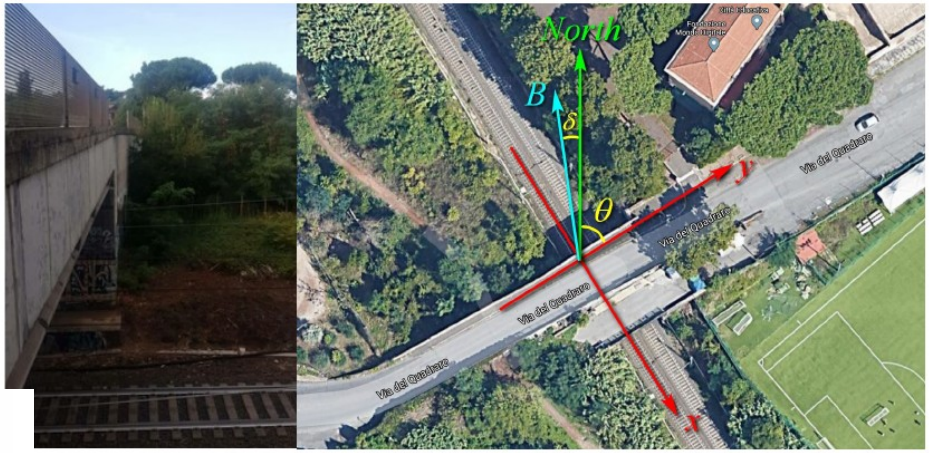
A. Suárez, D. Baccino, MM, AM, enviado 2020

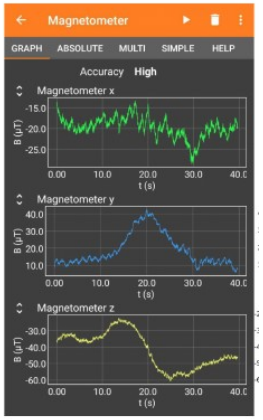
T8: campo magnético de trenes

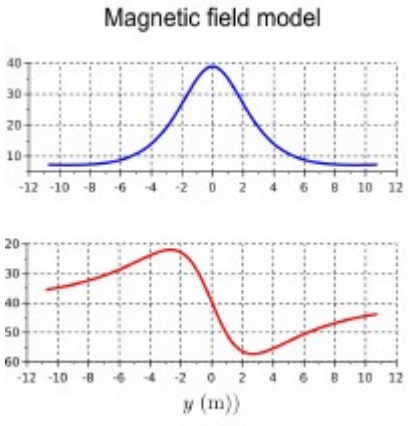
Try to imagine what the electric and magnetic fields look like at present in the space in this lecture room. First of all, there is a steady magnetic field; it comes from the currents in the interior of the earth—that is, the earth's steady magnetic field. Then there are some irregular, nearly static electric fields produced perhaps by electric charges generated by friction as various people move about in their









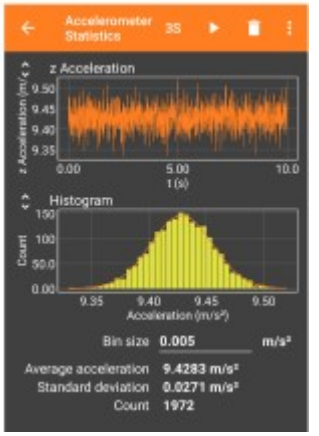


MM, Giovanni Organtini, AM, aceptado 2020

T9: fluctuaciones y sensores

An Approach to Teach Error Analysis and Uncertainties based on Mobile–device Sensors

Martin Monteiro, Cecilia Stari, Cecilia Cabeza, and Arturo C. Marti

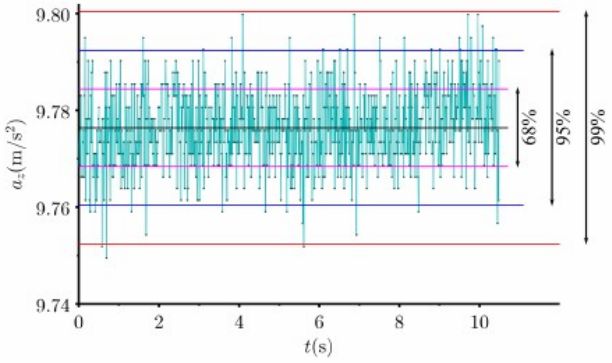


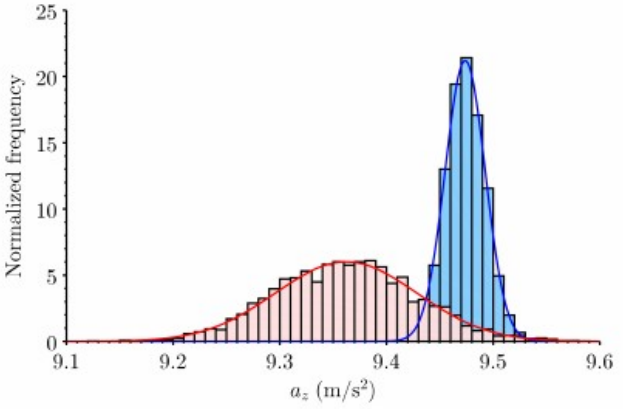
Los sensores presentan fluctuaciones alrededor del valor medio

Estas fluctuaciones son muy útiles para estudiar errores tipo “A”.

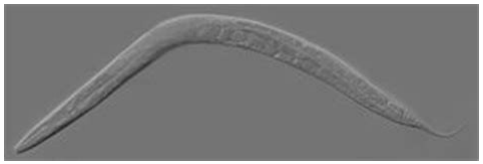
Es posible hacer en pocos segundos las prácticas que antes nos llevaban mucho tiempo

El conocimiento de las fluctuaciones puede aplicarse a diversos problemas





T10: memoria y SW



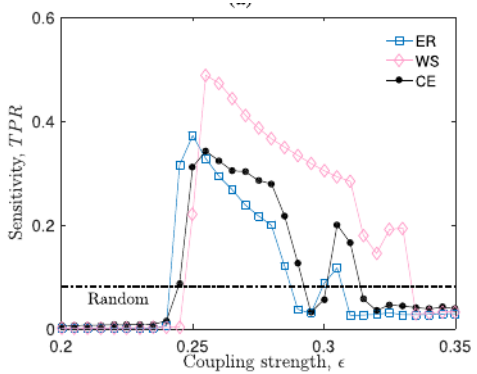
Small-worldness favours network inference in synthetic neural networks

Rodrigo A. García*, Arturo C. Martí, Cecilia Cabeza & Nicolás Rubido

SCIENTIFIC REPORTS | (2020) 10:2296 | https://doi.org/10.1038/s41598-020-59198-7

SCIENTIFIC REPORTS

natureresearch



Paper reciente de J. García-Ojalvo

Home > Chaos: An Interdisciplinary Journal of Nonlinear Science > Volume 30, Issue 6 > 10.1063/5.0009709

No Access . Published Online: 01 June 2020 Accepted: May 2020

Soft-wired long-term memory in a natural recurrent neuronal network

Chaos 30, 061101 (2020); https://doi.org/10.1063/5.0009709

Miguel A. Casal[1,2,3], Santiago Galella[1], Oscar Vilarroya[4,5], and Jordi Garcia-Ojalvo[1,a)]

Memoria a largo plazo y efecto small-world usando modelos sencillos de neuronas

The peculiar organization of the trajectories in the Mackey-Glass delayed model.

10.1109/TCSII.2019.2919651, IEEE Transactions on Circuits and Systems II: Express Briefs

TRANSACTIONS ON CIRCUITS AND SYSTEMS I, VOL. X, NO. Y, —

Exact Discrete-time Implementation of the Mackey-Glass Delayed Model

Pablo Amil, Cecilia Cabeza, Arturo C. Marti

CHAOS **25**, 043112 (2015)

Organization and identification of solutions in the time-delayed Mackey-Glass model

Pablo Amil,[1] Cecilia Cabeza,[1] Cristina Masoller,[2] and Arturo C. Martí[1]

Mackey-Glass model (1977)

Oscillation and Chaos in Physiological Control Systems

Michael C. Mackey, Leon Glass

Science, New Series, Volume 197, Issue 4300 (Jul. 15, 1977), 287-289.

- Respiratory and hematopoietic (formation of blood cellular components) diseases
- The production rate is not constant but depends on the state of the system at some *previous* time.
- There is *delay* between the initiation of cell production and the release into the blood.

$$\frac{dx}{dt} = \beta \frac{x_\tau}{1 + x_\tau^n} - \gamma x$$

Production rate

Delay $x_\tau = x(t-\tau)$

Decay rate

Looks simple but....

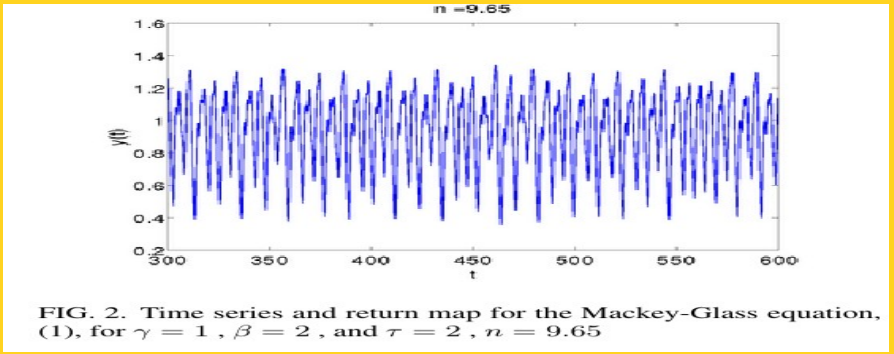


FIG. 2. Time series and return map for the Mackey-Glass equation, (1), for $\gamma = 1$, $\beta = 2$, and $\tau = 2$, $n = 9.65$

- First-order differential delay equation (DDE)
- Initial condition: **all the interval** $(-\tau, 0)$
-

Recurrence plots

Figures 3-12: Time delay embedding of slides initially presented at the November 1977 New York Academy of Sciences meeting. $x(t-2)$ is the ordinate and $x(t)$ is the abscissa with $\gamma = 1, \beta = 2$, and $\tau = 2$

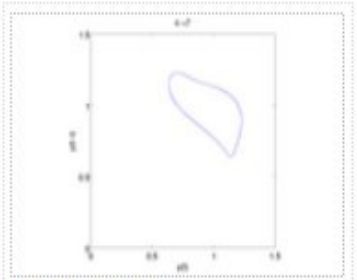


Figure 3: $n = 7$

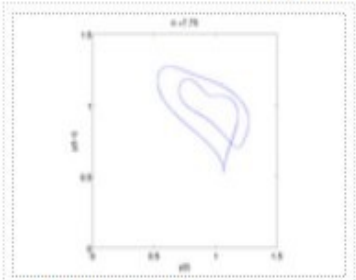


Figure 4: $n = 7.75$

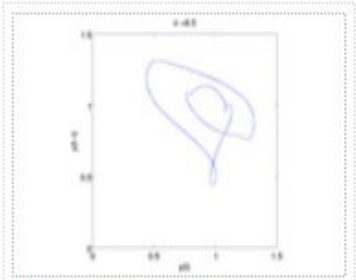


Figure 5: $n = 8.5$

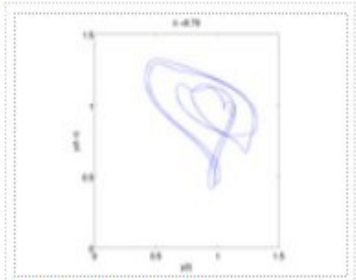


Figure 6: $n = 8.79$

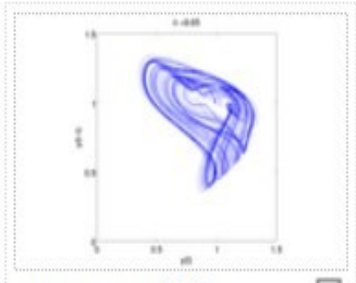


Figure 7: $n = 9.65$

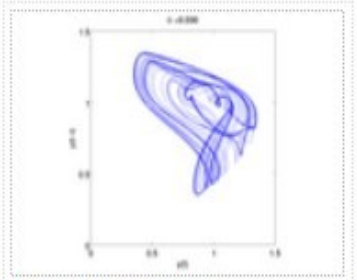


Figure 8: $n = 9.696$

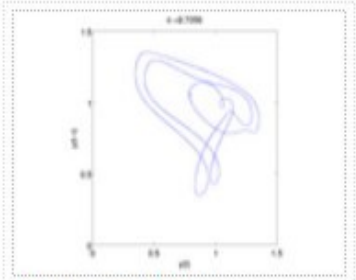


Figure 9: $n = 9.7056$

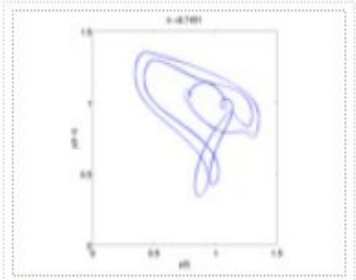


Figure 10: $n = 9.7451$

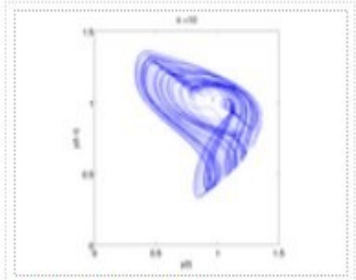


Figure 11: $n = 10$

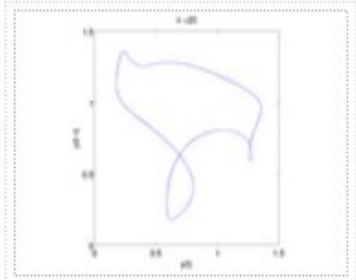


Figure 12: $n = 20$

+4000 cites to the original paper

Physica D: Nonlinear Phenomena
Volume 4, Issue 3, March 1982, Pages 366–393

Chaotic attractors of an infinite-dimensional dynamical system

J. Doyne Farmer*
Dynamical Systems Group, Physics Dept., U.C. Santa Cruz, Santa Cruz, Ca. 95064, USA

Physica D: Nonlinear Phenomena
Volume 9, Issues 1–2, October 1983, Pages 189–208

Measuring the strangeness of strange attractors

Peter Grassberger†, Itamar Procaccia
Department of Chemical Physics, Weizmann Institute of Science, Rehovot 76100, Israel

Browse Conference Publications > Adaptive Systems for Signal P ...

The unscented Kalman filter for nonlinear estimation

Full Te

2 Author(s)

Wan, E.A. ; Oregon Graduate Inst. of Sci. & Technol., Beaverton, OR, USA ; Van der Merwe, R.

APS » Journals » Phys. Rev. Lett. » Volume 59 » Issue 8
Phys. Rev. Lett. 59, 845–848 (1987)

Predicting chaotic time series

Abstract | References | Citing Articles (726) | Page Images

Download: PDF (266 kB) Export: BibTeX or EndNote (RIS)

J. Doyne Farmer and John J. Sidorowich
Theoretical Division and Center for Nonlinear Studies, MS B258, Los Alamos National Laboratory, Los Alamos, New Mexico 87545

Received 22 April 1987; published in the issue dated 24 August 1987

PHYSICAL REVIEW E **75**, 016207 (2007)

Dual synchronization of chaos in Mackey-Glass electronic circuits with time-delayed feedback

Satoshi Sano,[1] Atsushi Uchida,[1,2] Shigeru Yoshimori,[1] and Rajarshi Roy[2,3,4]
[1]*Department of Electronics and Computer Systems, Takushoku University, 815-1 Tatemachi, Hachioji, Tokyo 193-0985, Japan*
[2]*IREAP, University of Maryland, College Park, Maryland 20742, USA*
[3]*IPST, University of Maryland, College Park, Maryland 20742, USA*
[4]*Department of Physics, University of Maryland, College Park, Maryland 20742, USA*
(Received 18 August 2006; published 12 January 2007)

We experimentally and numerically demonstrate the dual synchronization of chaos in two pairs of one-way-coupled Mackey-Glass electronic circuits with time-delayed feedback. The outputs of the two drive circuits are mixed and used both for the feedback signal to the two drive circuits and for the transmission signal to the two response circuits. We investigate the regions for achieving dual synchronization of chaos when the delay time

RAPID COMMUNICATI

PHYSICAL REVIEW A VOLUME 28, NUMBER 4 OCTOBER 1983

Estimation of the Kolmogorov entropy from a chaotic signal

Peter Grassberger
Physics Department, University of Wuppertal, D-5600 Wuppertal 1, Germany

Itamar
Chemical Physics Department, Weizmann
(Received

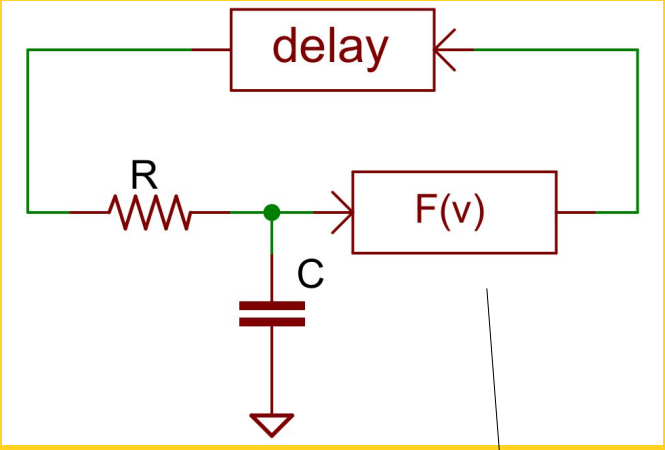
A new method for estimating the Kolmogorov en
on examples. The method should prove valuable fo

Contents lists available at SciVerse ScienceDirect
Physics Letters A
www.elsevier.com/locate/pla

Intricate routes to chaos in the Mackey–Glass delayed feedback system

Leandro Junges [a,b], Jason A.C. Gallas [a,b,c,*]

Our experiment: Electronic implementation



Function block → "arbitrary" nonlinear function

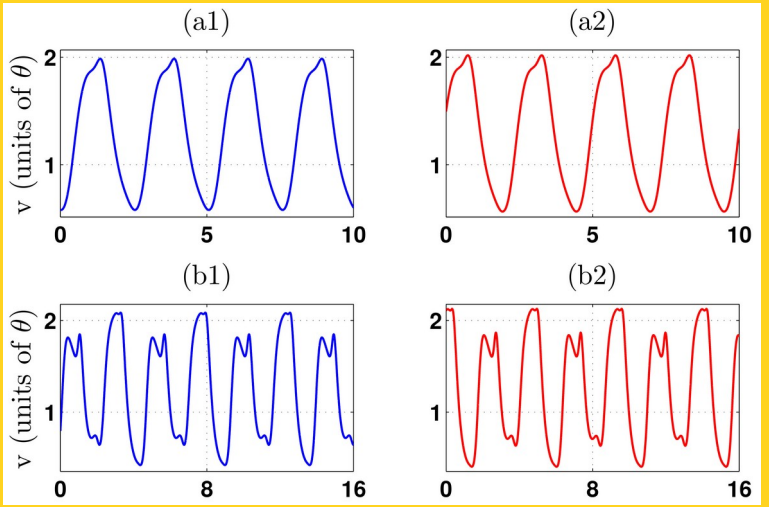
Bucket bridge device: analogy with the term *bucket brigade*, (line of people passing buckets of water)

$N \sim 1000$

- **Pre and post amplification → low noise**
- **Analog voltage, discrete time**
- **Effective equation → exact temporal integration**
- **Continuous limit → original equation**

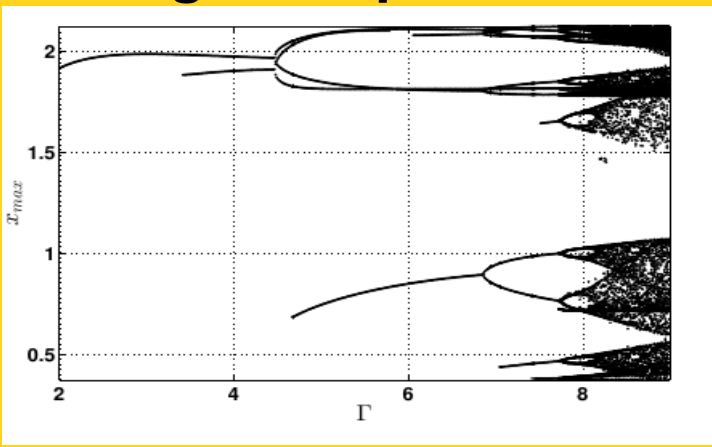
P. Amil et al. TCAS II, 2015

Bifurcation diagrams

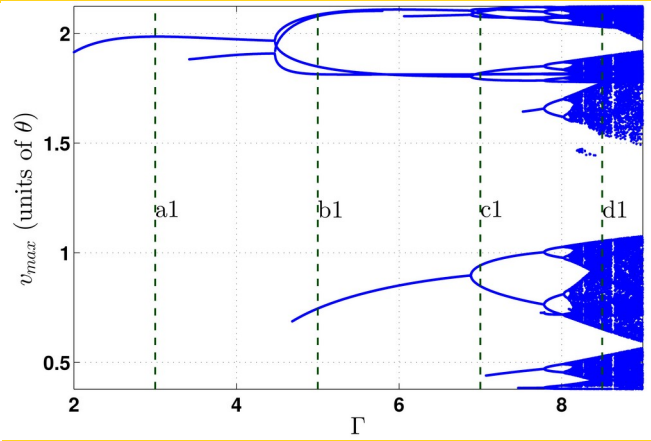


- Maxima of the temporal series
- Increasing the time-delay

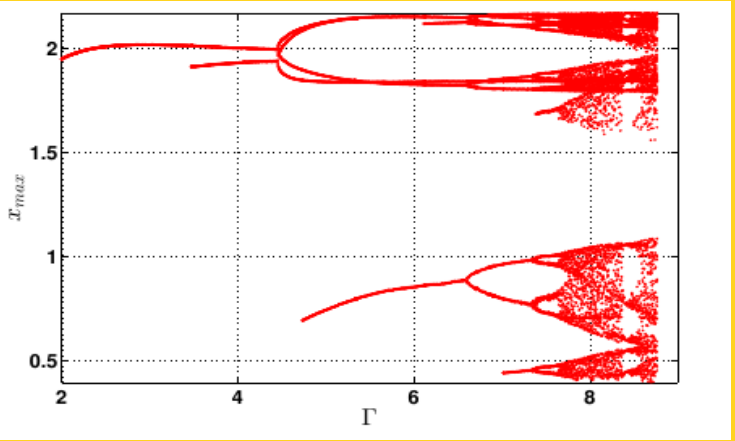
Original equation:



Discrete equation:

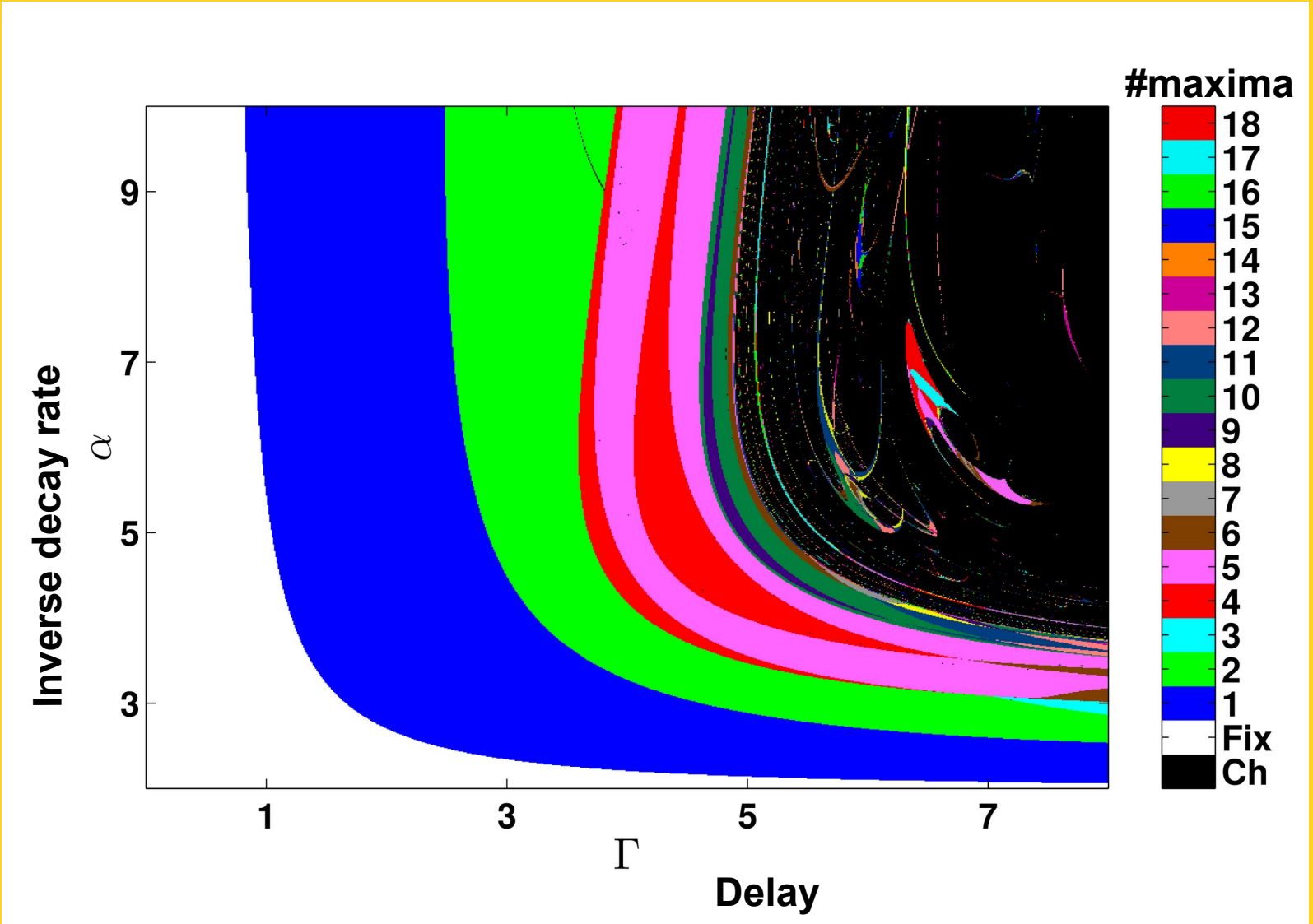


Experimental:



- Period doubling
- Isolated branches (begin or end abruptly)!!!
- Particular of DDEs.

Periodicity in the parameter space



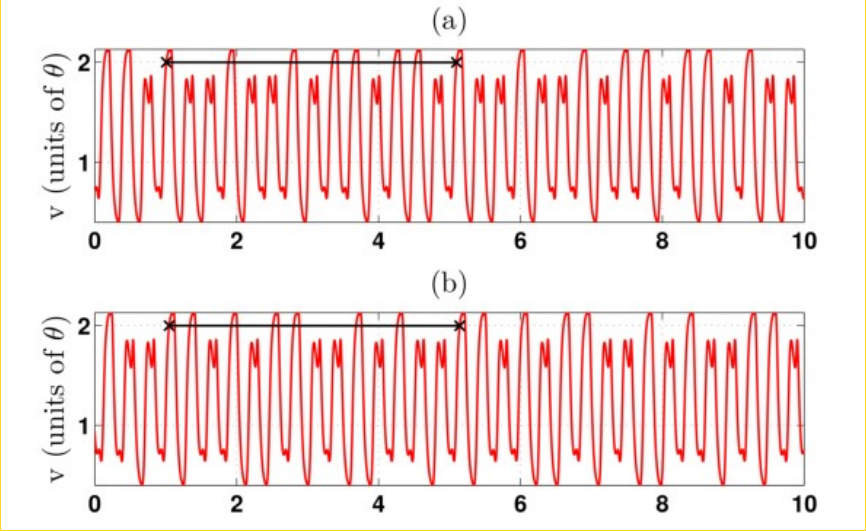
P. Amil et al. CHAOS, 2015

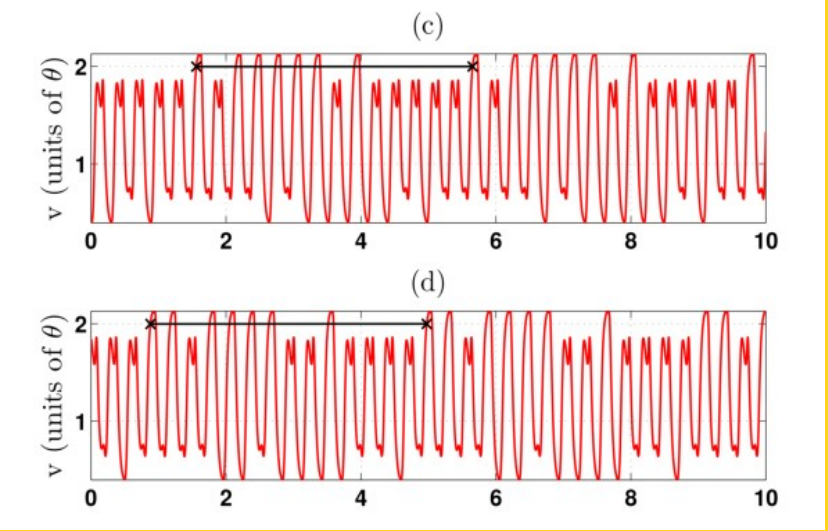
Multistability

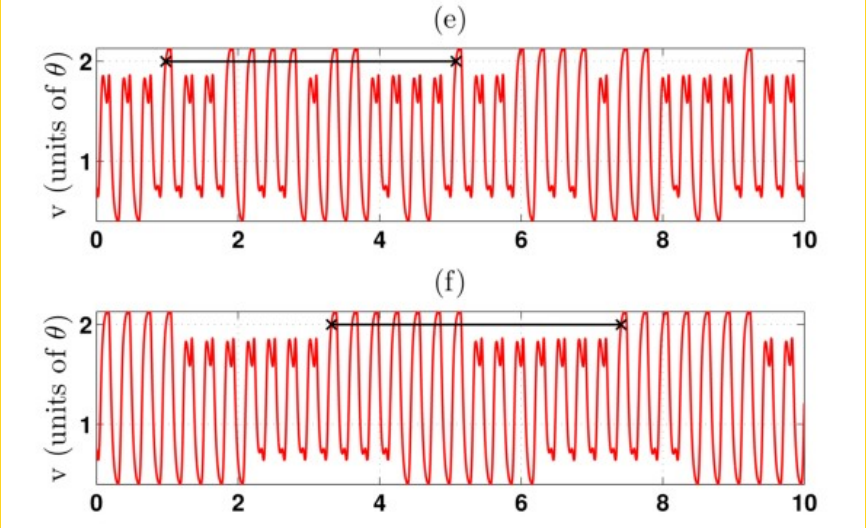
Different initial functions (IFs)

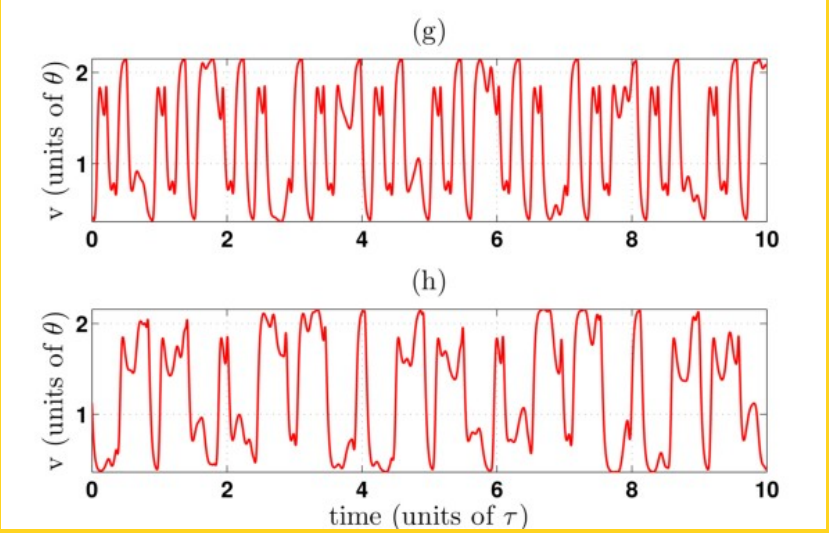
$$F_0(t) = \frac{1}{40}\sin\left(\frac{7\pi t}{2\tau} + \phi\right)\sin\left(\frac{7\pi t}{\tau} + 2\phi\right) + v_{\text{off}},$$

Coexistence of different solutions (different alternations of peaks)



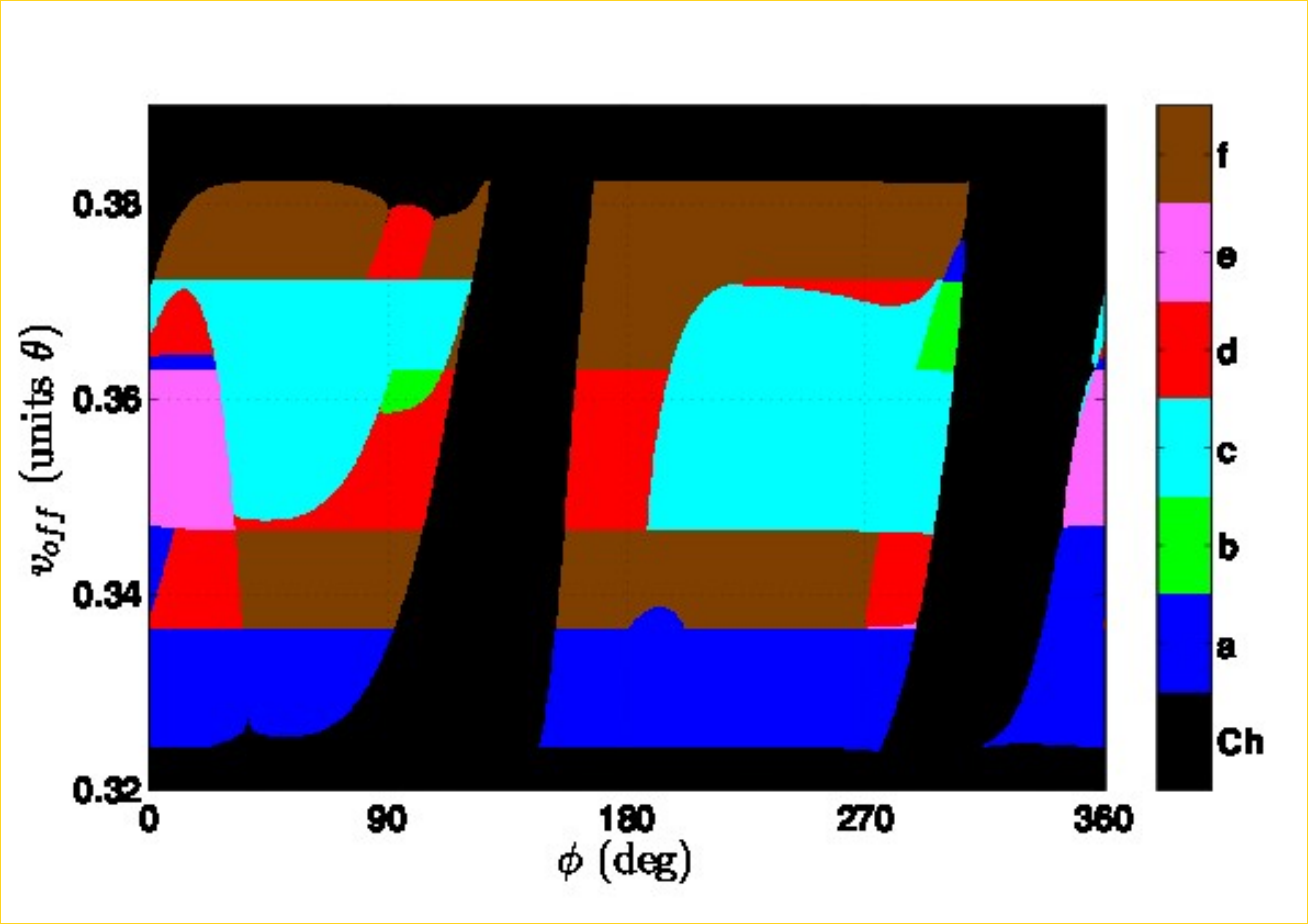






Initial conditions space

Symbolic algorithm to classify the solutions:



Different solutions

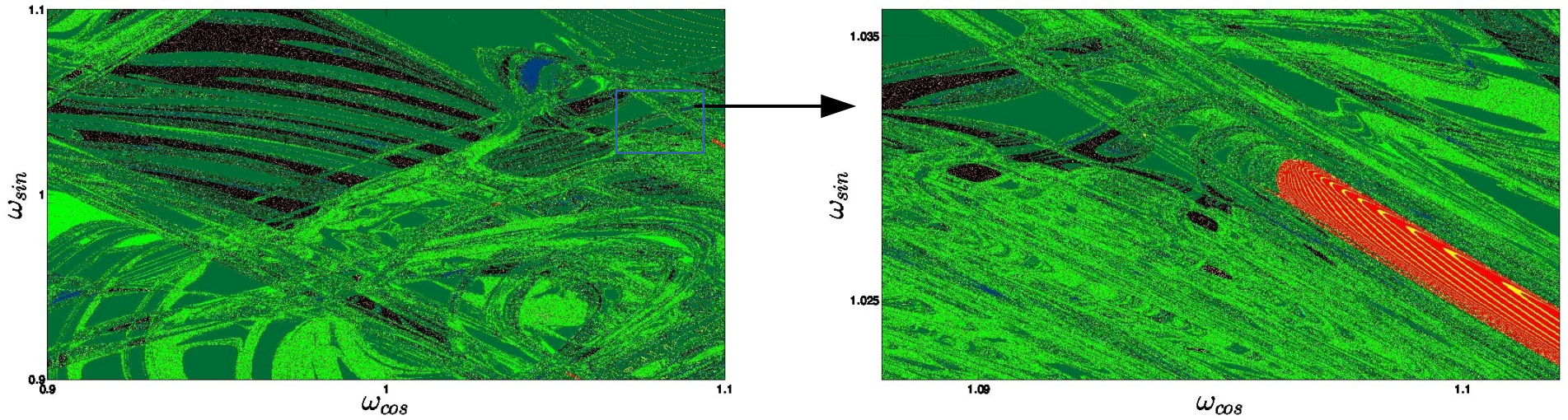
Labels as in the previous slide

$$F_0(t) = \frac{1}{40}\sin\left(\frac{7\pi t}{2\tau} + \phi\right)\sin\left(\frac{7\pi t}{\tau} + 2\phi\right) + v_{\text{off}},$$

Seudo-random initial functions

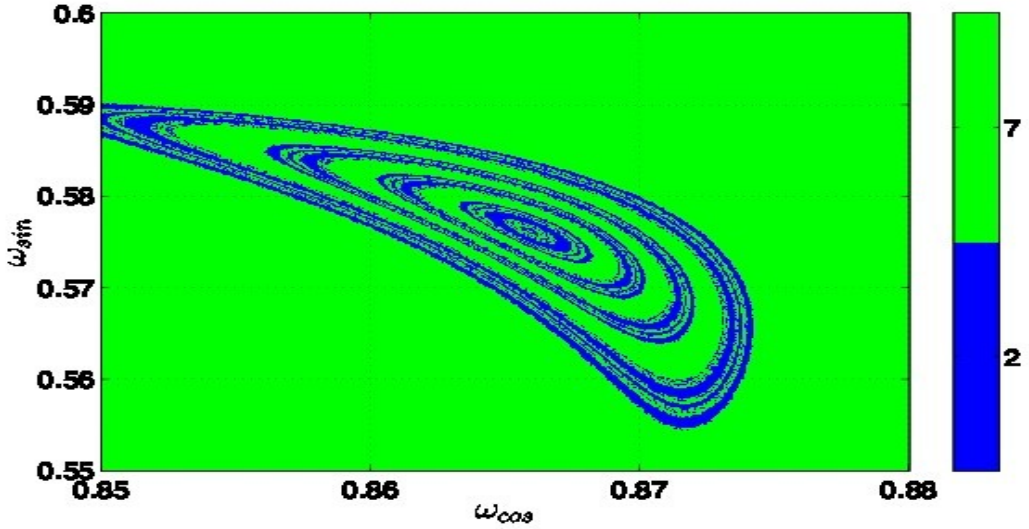
$$F_0 = 2 + \sin(\omega_{sin} 2\pi t/\tau) + \cos(\omega_{cos} 2\pi t/\tau).$$

Zoom

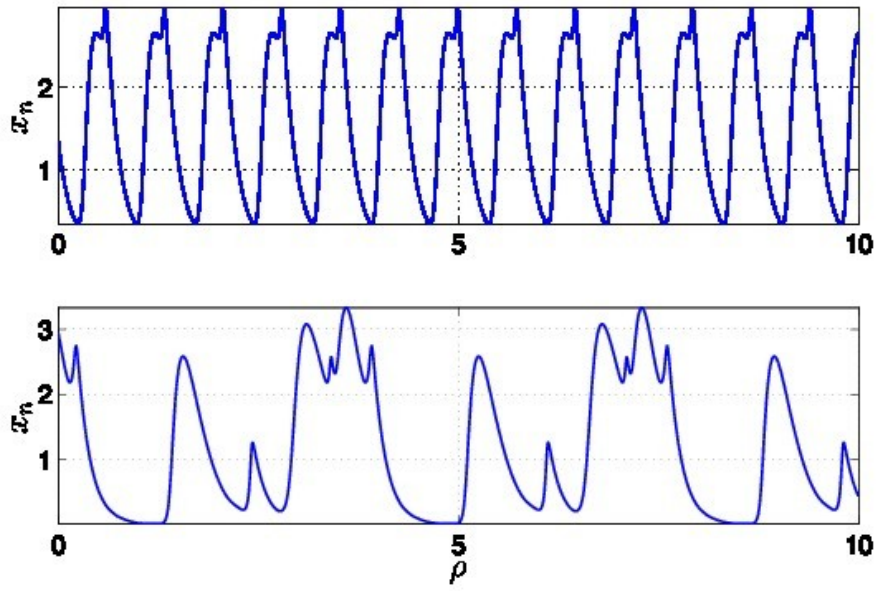


Different initial conditions
Colors indicate number of maxima (black chaos)

More structures:



$$F_0 = 2 + \sin(\omega_{sin} 2\pi t/\tau) + \cos(\omega_{cos} 2\pi t/\tau).$$

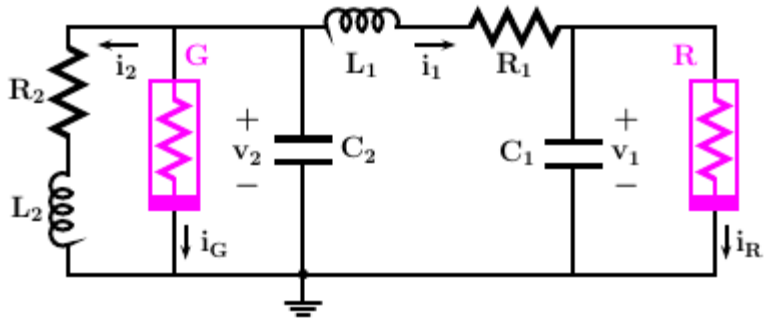


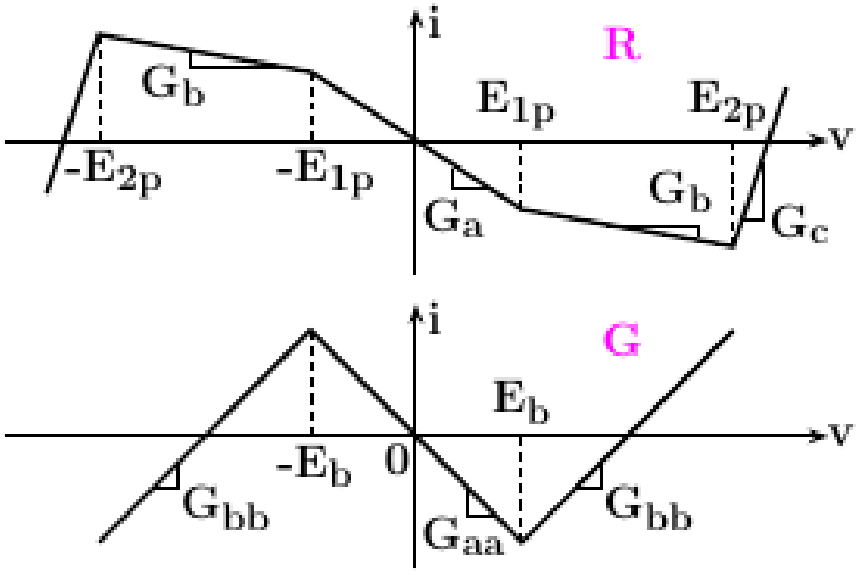
Comentarios:

- Electronic system with time delay mimicking MG model
- Exact temporal evolution
- Coexistence of different solutions (equal period, different alternation of peaks)
- Peculiar organization in the initial condition space
- Robust to noise and parameter mismatch
- Isospike diagrams do not fully characterize the behavior.
- Applications: memory storage? pattern reconigtion?

T11”: sistemas con retardo, nuevos estudios

Resistencias no lineales





Modelo de Mackey-Glass con resistencia nolineal

Gracias por su atención!