THE DYNAMICS OF SUCCESS, FAME and CRISES

(Commercial sales, YouTube success, volatility shocks, cyber-risks, conflicts, epilepsy, earthquakes, landslides, social crises, climate,...)

Didier SORNETTE

ETH Zurich
Department of Management, Technology and Economics, Switzerland

Member of the Swiss Finance Institute

co-founder of the Competence Center for Coping with Crises in Socio-Economic Systems, ETH Zurich (http://www.ccss.ethz.ch/)

Professor of Physics associated with the Department of Physics (D-PHYS), ETH Zurich

Professor of Geophysics associated with the Department of Earth Sciences (D-ERWD), ETH Zurich

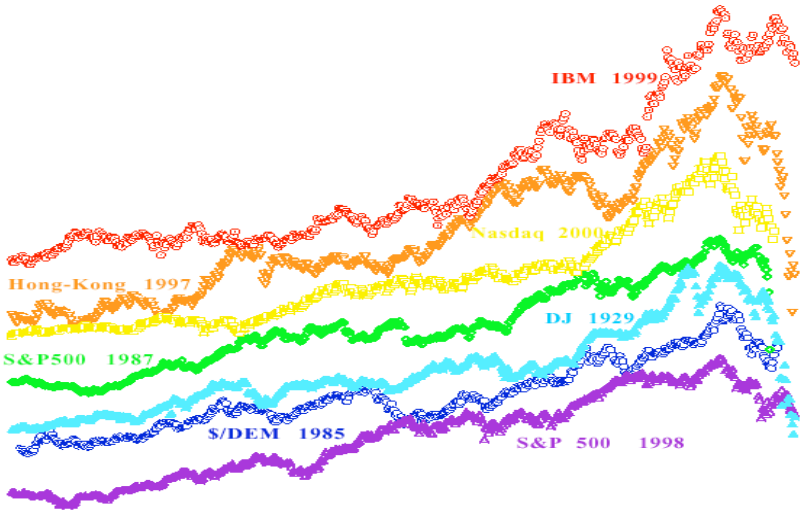
www.er.ethz.ch

EXTREME EVENTS in Natural SYSTEMS

- Earthquakes
- Volcanic eruptions
- Hurricanes and tornadoes
- Landslides, mountain collapses
- Avalanches, glacier collapses
- Lightning strikes
- Meteorites, asteroid impacts
- Catastrophic events of environmental degradations

EXTREME EVENTS in SOCIO-ECONOMIC SYSTEMS

- Failure of engineering structures
- Crashes in the stock markets
- Social unrests leading to large scale strikes and upheavals
- Economic recessions on regional and global scales
- Power blackouts
- Traffic gridlocks
- Social epidemics
- **Block-busters**
- **Discoveries-innovations**
- **Social groups, cities, firms...**
- **Nations**
- Religions...



Endogenous versus Exogenous

Extinctions

- -meteorite at the Cretaceous/Tertiary KT boundary
- -volcanic eruptions (Deccan traps)
- -self-organized critical events

Discoveries

- -serendipity
- -maturation

Financial crashes

- -external shock
- -self-organized instability

Volatility bursts in financial time series

- -external shock
- -cumulative effect of "small" news

Earthquakes

- -tectonic driving
- -triggering

Immune system

- -external viral or bacterial attack
- - " internal" (dis-)organization

Parturition

- -mother/foetus triggered?
- -mother-foetus complex?

Brain (learning)

- -external inputs
- -internal self-organization and reinforcements (role of sleep)

Aviation industry recession

- -September 11, 2001
- -structural endogenous problems

Commercial success and sales

- -Ads
- -epidemic network

Recovery after wars

- -internally generated (civil wars)
- -externally generated

Social unrests

- -triggering factors
- -rotting of social tissue

Endogenous versus Exogenous

Cancinogenesis

-gene mutations (somatic mutation theory)

-anomalous communications between cells and proliferation of cells is the normal state (tissue organization field theory) (Sonnenschein-Soto)

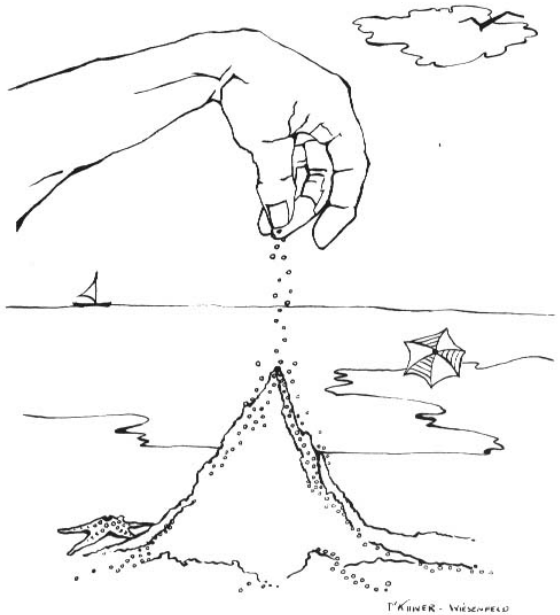
Cells are in a default state of proliferation and motility — constantly maintaining homeostasis of the tissue through cellular communication and organization.

Disruption of this organization can lead to disease states, such as cancer, as carcinogens target whole tissues, not just individual cells.

Inter-cell interactions depend on local context in tissues, more than genetic programs.

- **Self-organization?**

Extreme events are just part of the tail of power law distribution due to "self-organized criticality"? (endogenous)



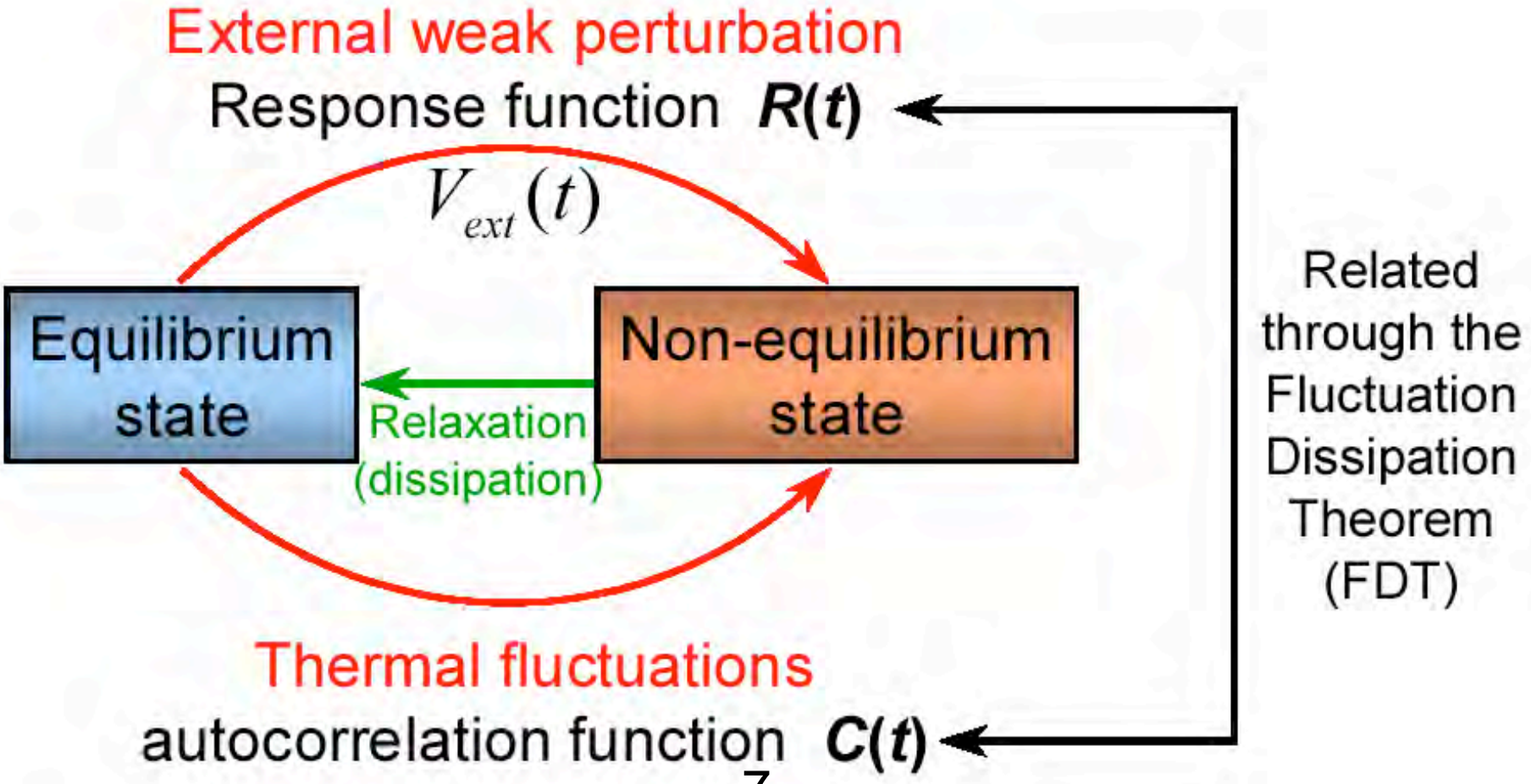
Artwork by Elaine Wiesenfeld
(from Bak, How Nature Works)

- **"Catastrophism": extreme events require extreme causes that lie outside the system (exogenous)**

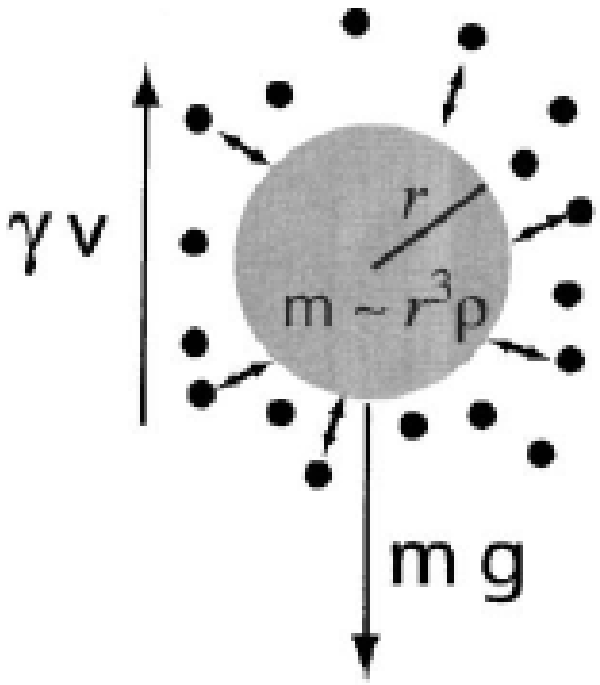
- **A mixture? How would it work?**

Response Theory

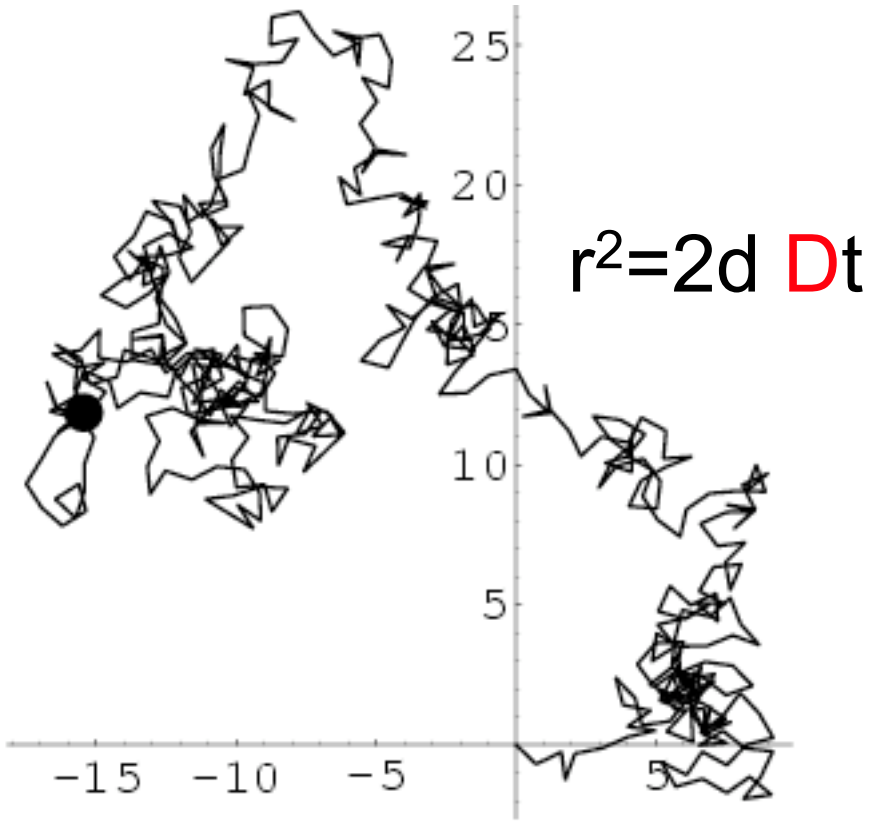
("Impulse response" approach in Econometrics)



EXO:Drag resistance
under an external force



ENDO: Random walk



$r^2=2d\,Dt$

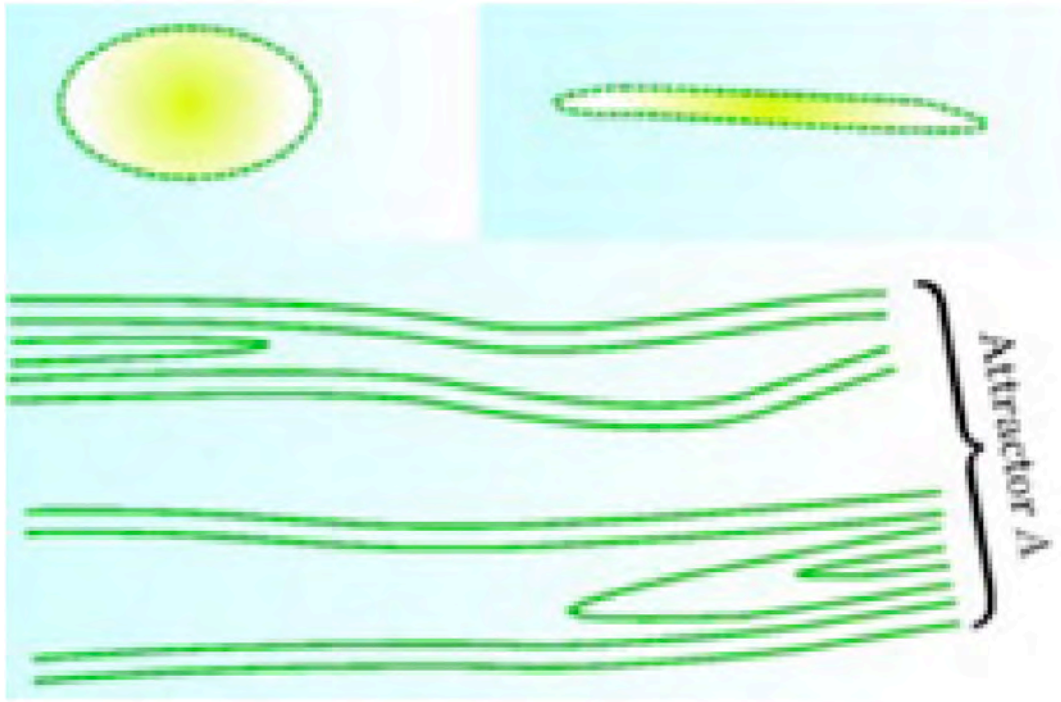
$$D=k_BT/\gamma$$

(Einstein, 1905)

Fluctuation-dissipation theorem far from equilibrium is not expected to hold in general, but...

- Externally imposed perturbations may be different from spontaneous fluctuations (external fluctuations lie outside the complex attractor)

- Attractor of dynamics may exhibit bifurcations



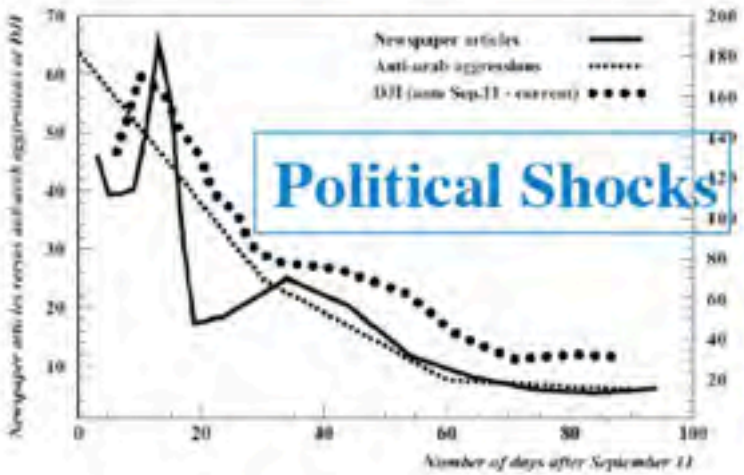
D. Ruelle, Physics Today, May 2004

STRATEGY

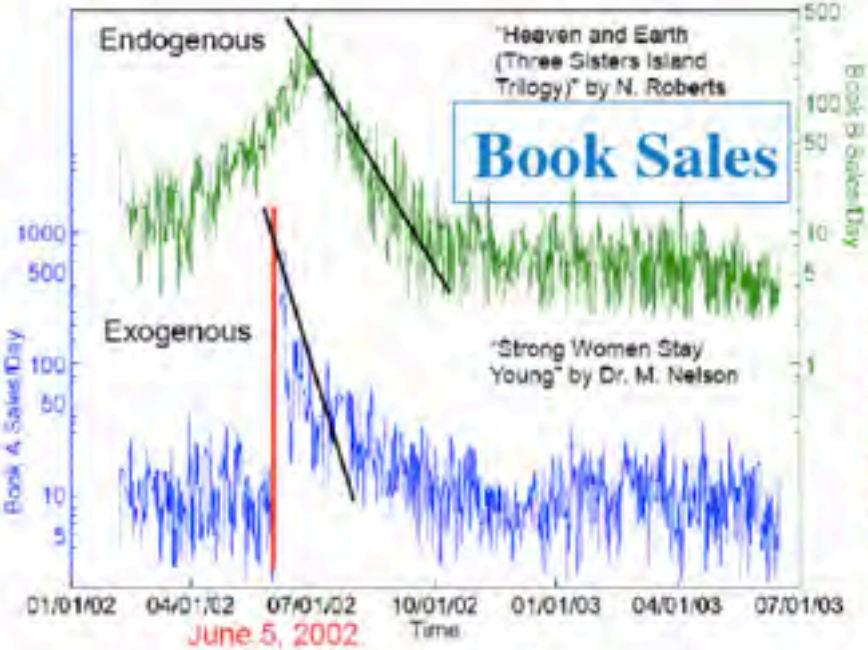
- Identify the extremes (and sub-hierarchies)
- Look for local peaks and bottoms
- Analyze the dynamics around these extremes
  - ★Are they abrupt?
  - ★smooth?
  - ★regular?
  - ★stochastic?
- Identification of different regimes
  - ★subcritical
  - ★super-critical...
- Diagnostic of underlying mechanism
- Predictability

Epidemics in Socio-Economic Networks

Roehner, Sornette & Andersen (2004)



Political Shocks



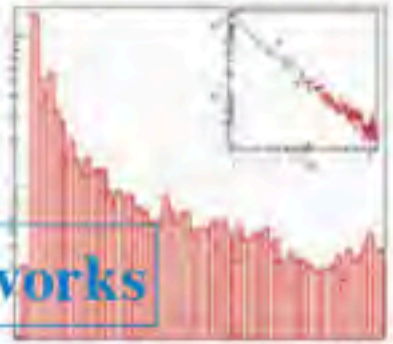
June 4, 2002: New York Times article crediting the "groundbreaking research" of Dr Nelson

S&P 500

Financial Markets

Somette etal, PRL (2004)
Somette etal J.Phys (1996)

YouTube Views



Social Networks

Crane et Sornette (2008)

AMAZON BOOK SALES

- Amazon.com posts a "live" ranking of all its products
- Book ranks in the top 10,000 are updated every hour according to a secret weighting of recent sales and entire history

amazon.com

Top 100 Bestsellers
Updated Hourly

1. *The South Beach Diet*
by Arthur Agatston (Author)
Price: $14.97 You Save: $9.98 (40%) Used & new from $13.24

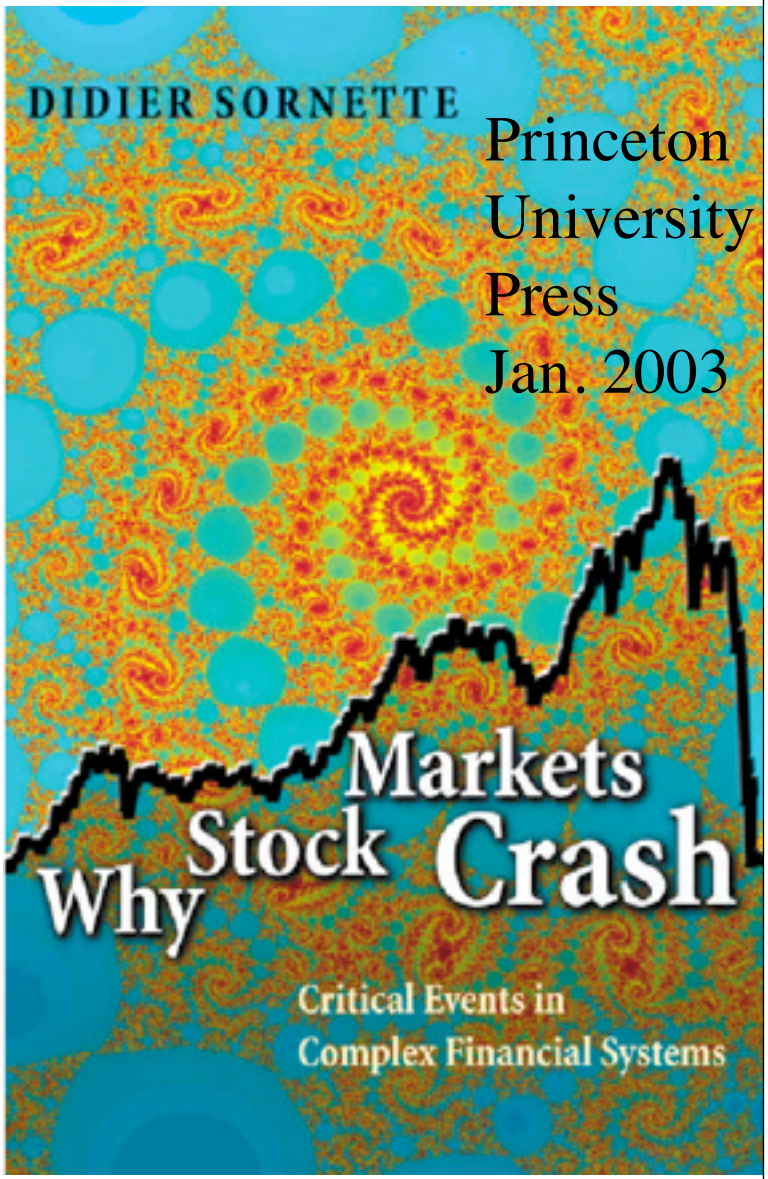
2. *The Da Vinci Code*
by Dan Brown (Author)
Price: $14.97 You Save: $9.98 (40%) Used & new from $10.80

3. *The Last Juror*
by John Grisham (Author)
Price: $19.57 You Save: $8.38 (30%)

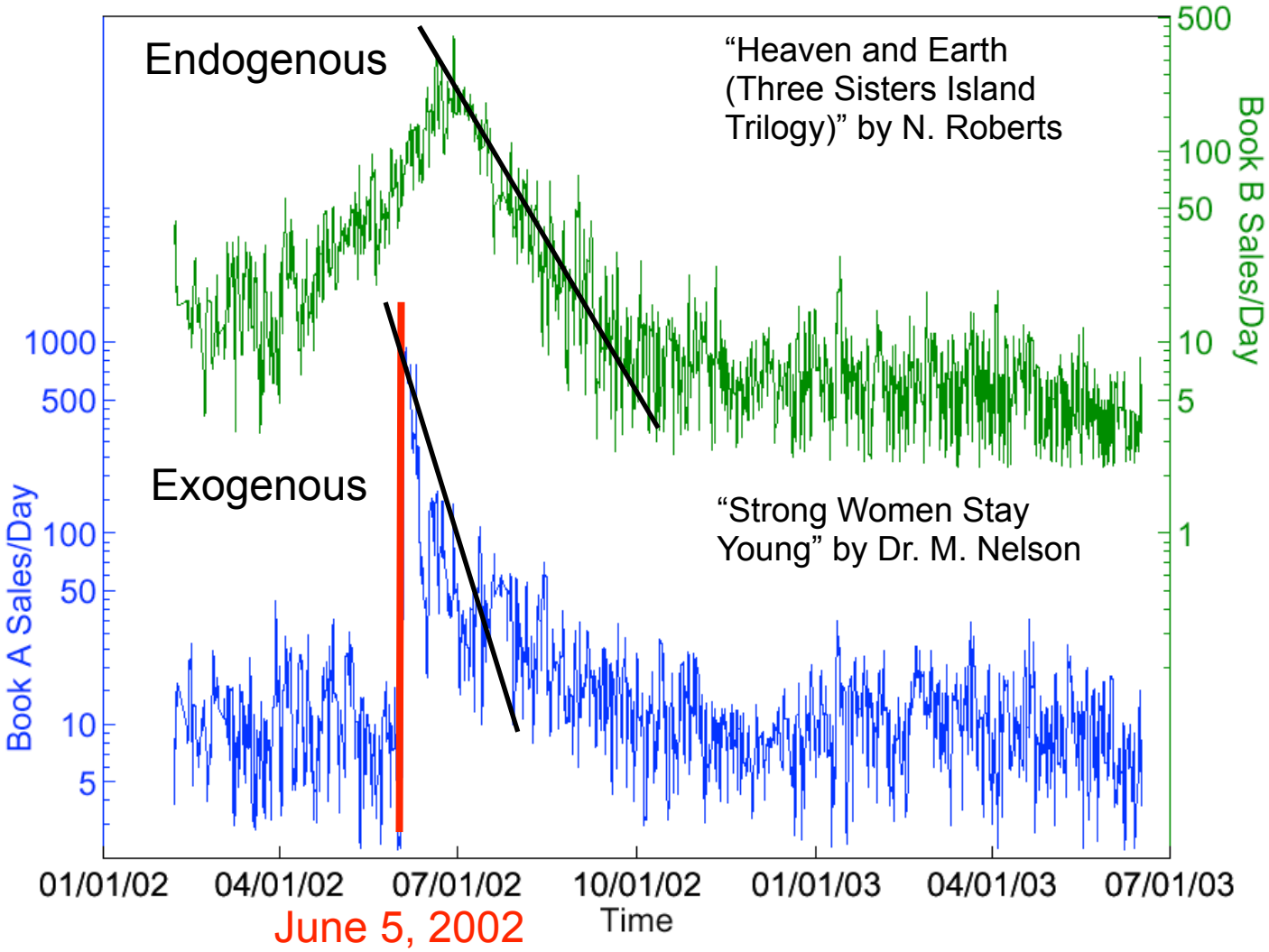
4. *South Beach Diet Good Fats/Good Carbs Guide*
by Arthur Agatston (Author)
Price: $7.99 Used & new from $7.80

The Original “Shock”

- On Friday January 17, 2003, Sornette’s recent book jumped to rank # 5 on Amazon.com’s sales ranking (with Harry Potter as #1!!!)
- Two days before: release of an interview on MSNBC’s MoneyCentral website



Book sales dynamics



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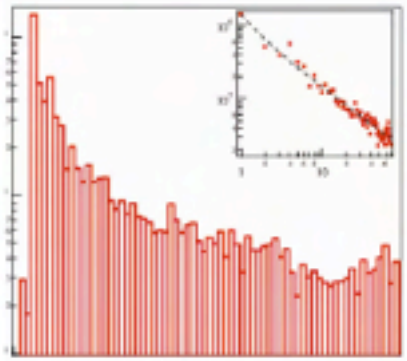
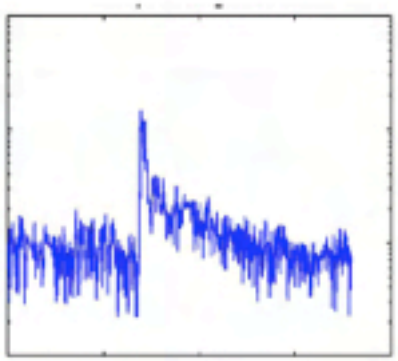
Typical Relaxation Dynamics

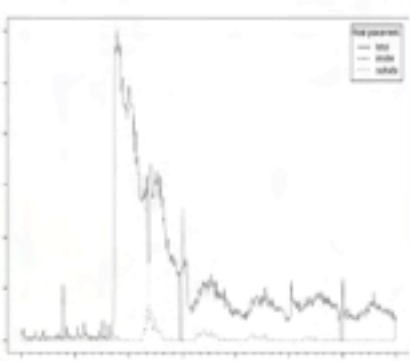
YouTube Views



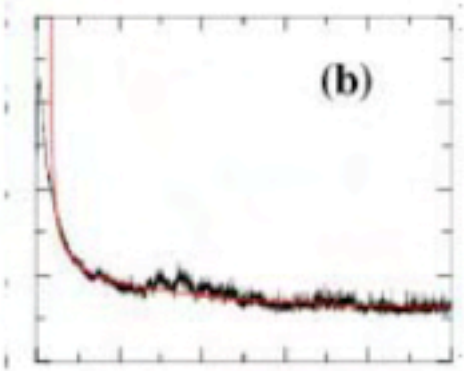
Book Sales



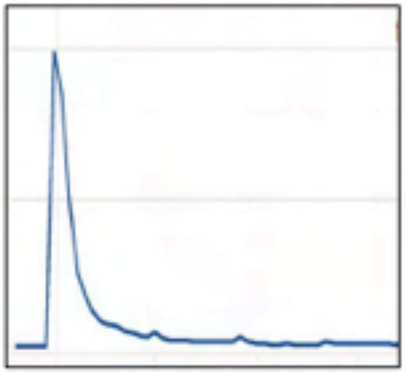
Computer Worm



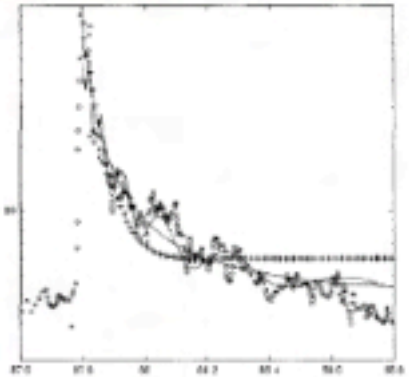
Web Visitation



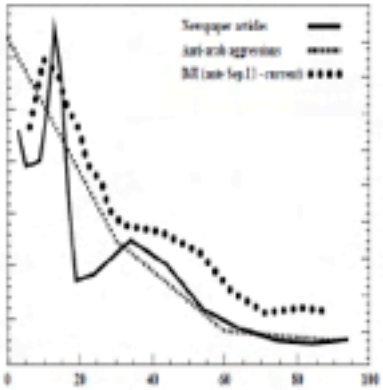
Search Queries



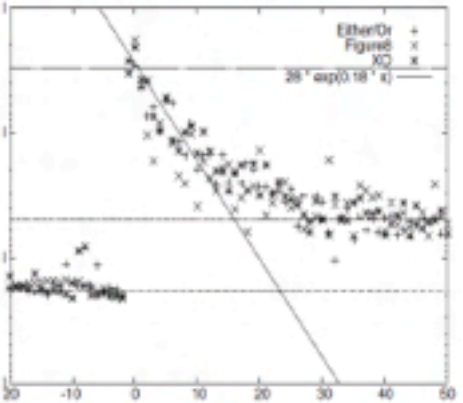
S&P 500



September 11



Music Sales



Crane etal, PNAS (2008)
Google Trends

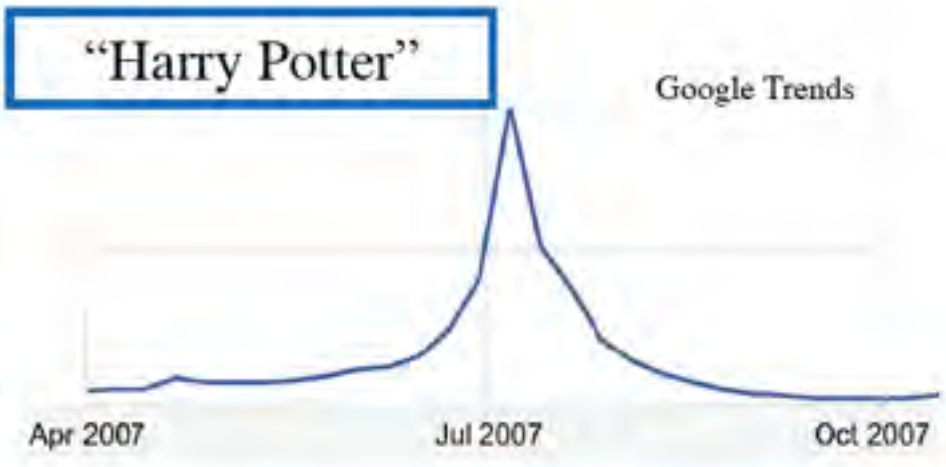
Sornette etal, PRL (2004)
Sornette etal J.Phys (1996)

Crane etal working paper (2009)
Roehner etal J.Mod.Phys (2004)

Dezso et al PRE (2006)
Lambiotte et al Physica A (2006)

Collective Behaviors
in the Information Sphere

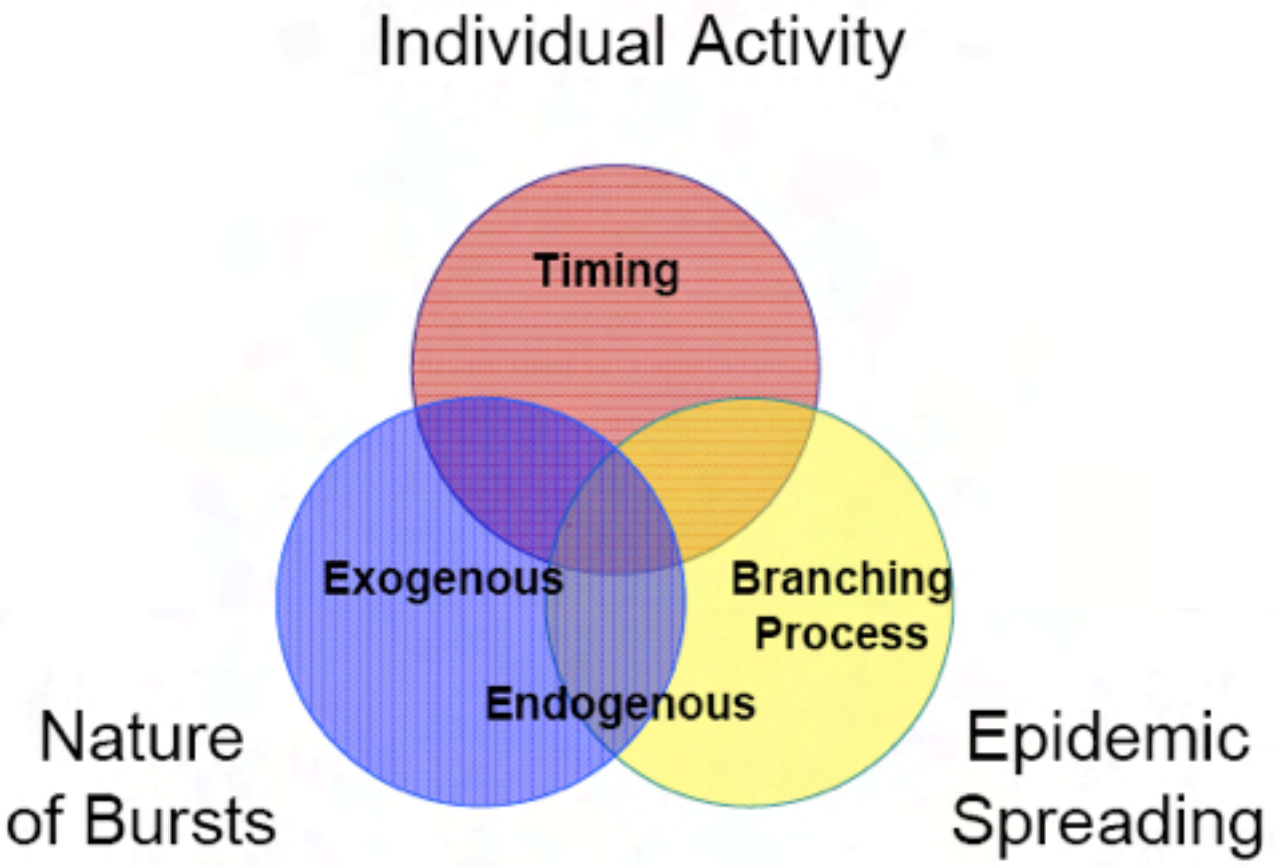
Exogenous shocks (90%)



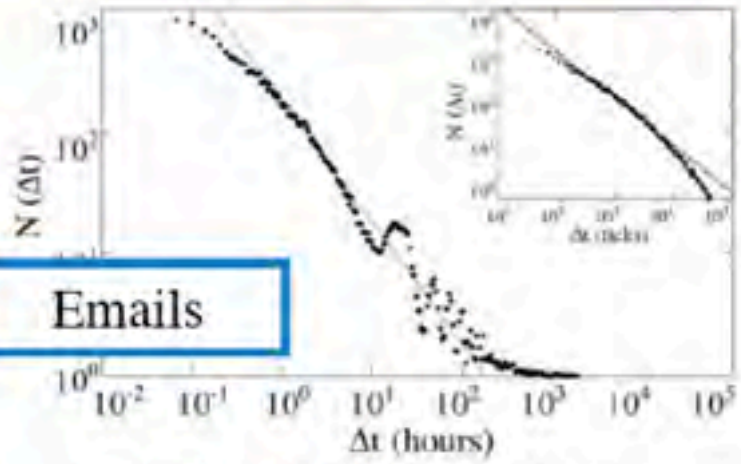
Endogenous shocks (10%)

➡ Laws of Social Dynamics

Disentangling the pieces

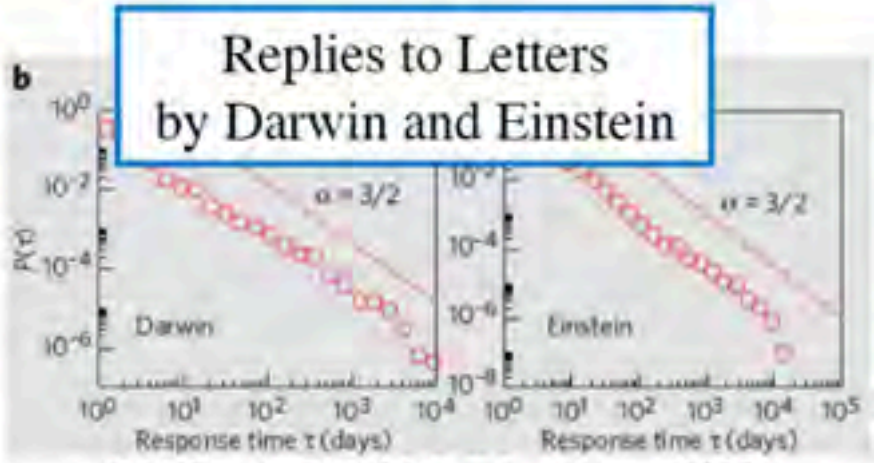


Waiting Times in Humans Dynamics



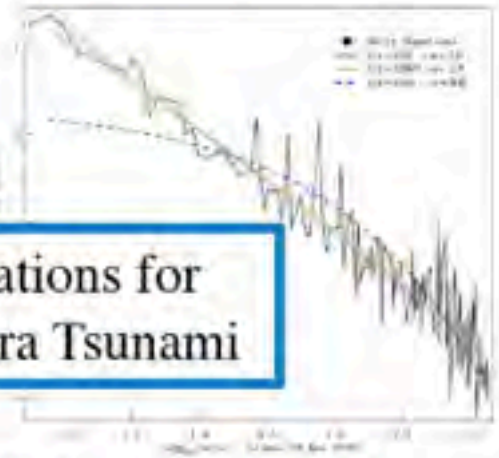
Emails

Eckmann et al., *PNAS* (2004)



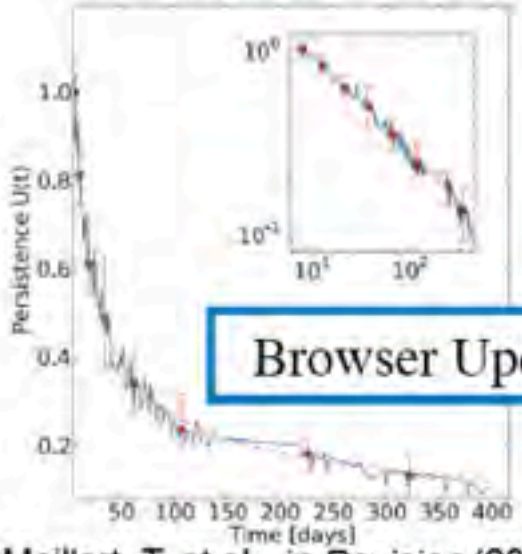
Replies to Letters by Darwin and Einstein

Oliveira, J., Barabási, A-L, *Nature* (2005)



Donations for Sumatra Tsunami

Crane, R., Sornette, D. and Schweitzer, F. , *PRE* (2010)



Browser Updates

Maillart, T. et al., *in Revision* (2010)

Exogenous Shocks

F. Deschatres and D. Sornette, The Dynamics of Book Sales: Endogenous versus Exogenous Shocks in Complex Networks, Phys. Rev. E 72, 016112 (2005)

Oprah Winfrey

amazon.com

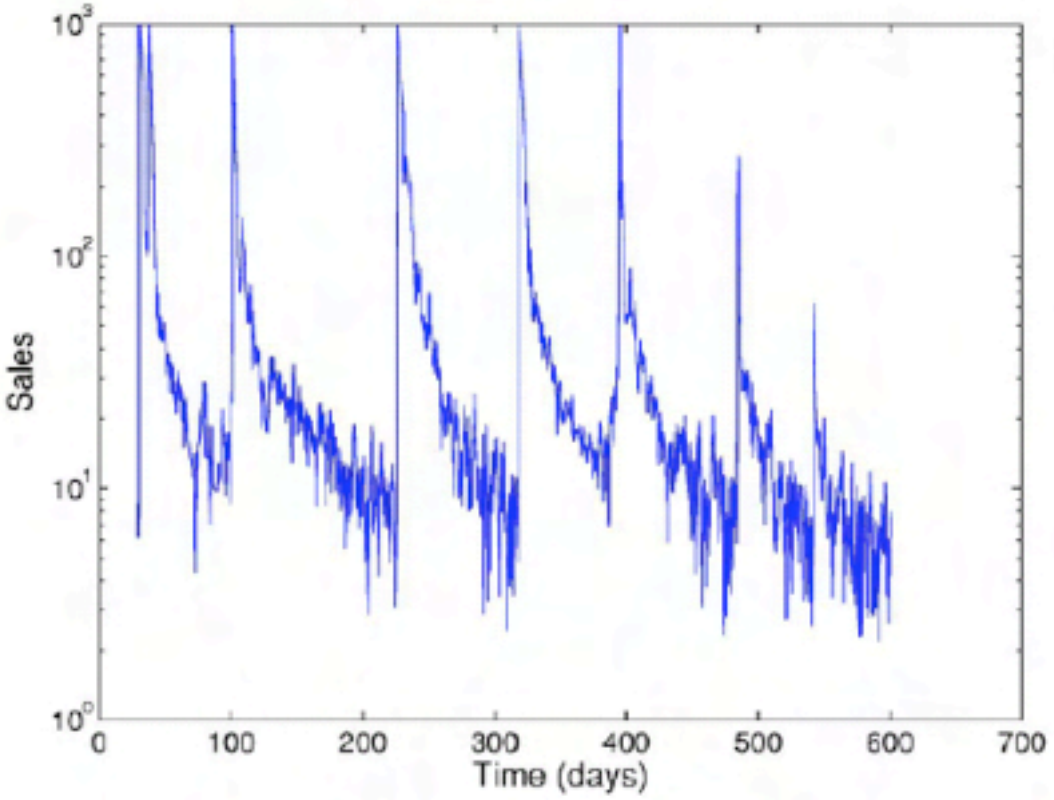
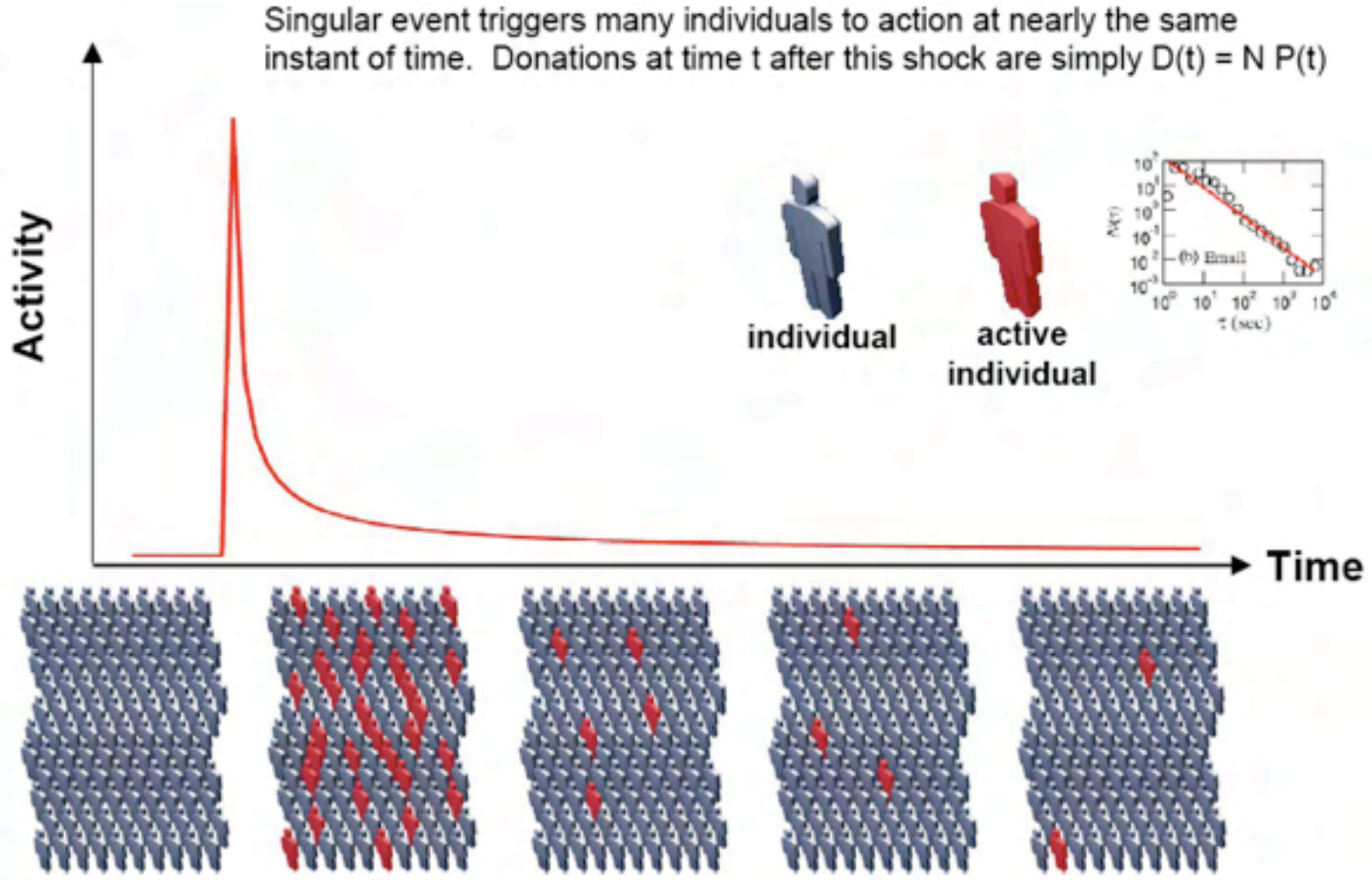
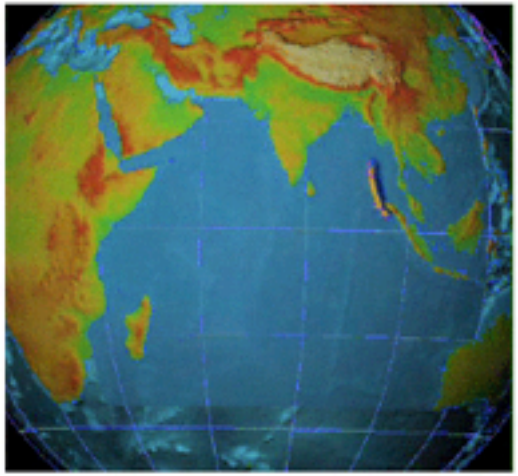


FIG. 8. (Color online) Time evolution of the book "Get with the Program" (see Table III).

Probability density function of waiting times
~
rate of activity triggered by an exo-shock
(if no epidemic process at work = far from criticality)



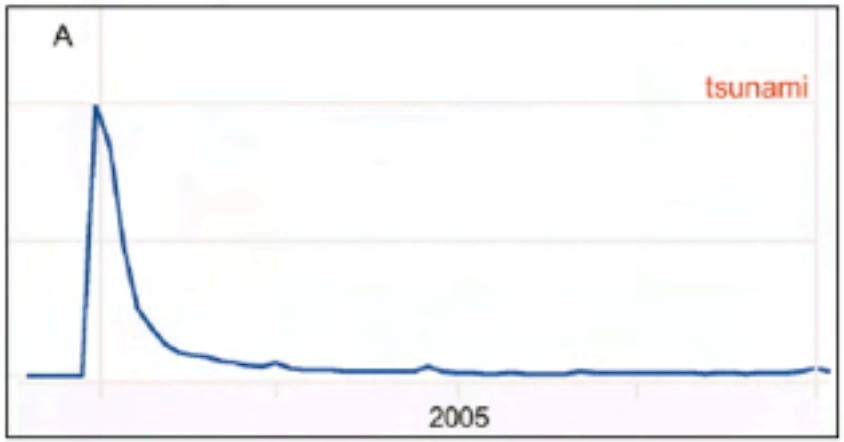
Sumatra Earthquake and Tsunami



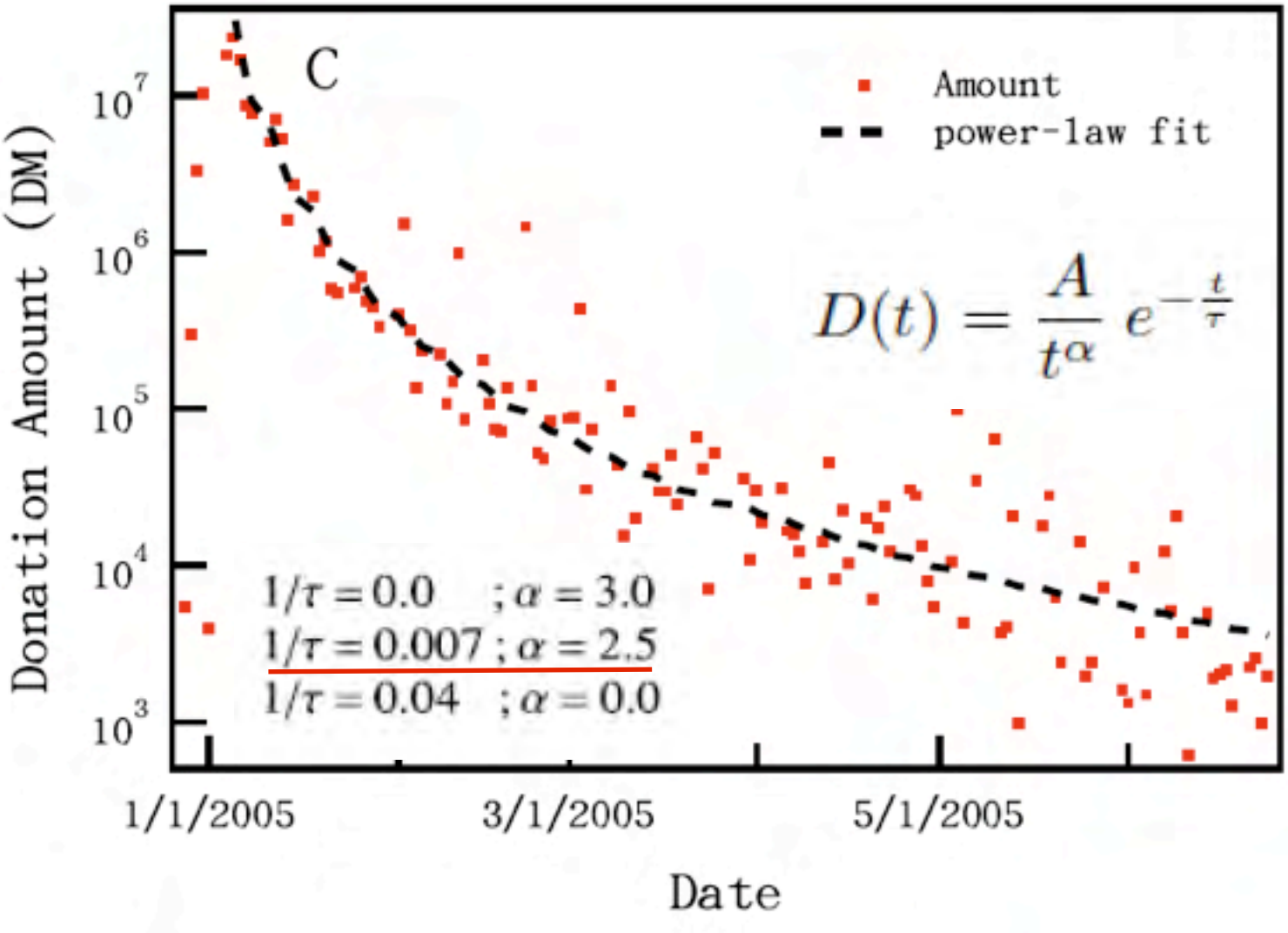
Occuring on December 26, 2004, with a magnitude of between 9.1 and 9.3, it is the second largest earthquake ever recorded on a seismograph. This earthquake had the longest duration of faulting ever observed, between 8.3 and 10 minutes.

It caused the entire planet to vibrate as much as 1 cm (0.4 inches) and triggered other earthquakes as far away as Alaska

Search Queries for the word "Tsunami"



Sumatra Earthquake and Tsunami



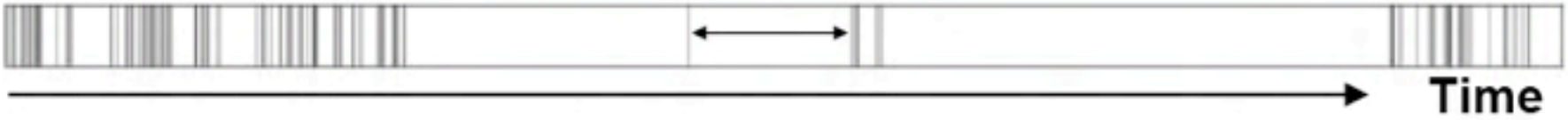
R. Crane, F. Schweitzer and D. Sornette, New Power Law Signature of Media Exposure in Human Response Waiting Time Distributions, Physical Review E 81, 056101 (2010)

Models of Human Activity

Model 1: Random, Poisson

Consecutive events occur with some regularity, characterized by some "average" time

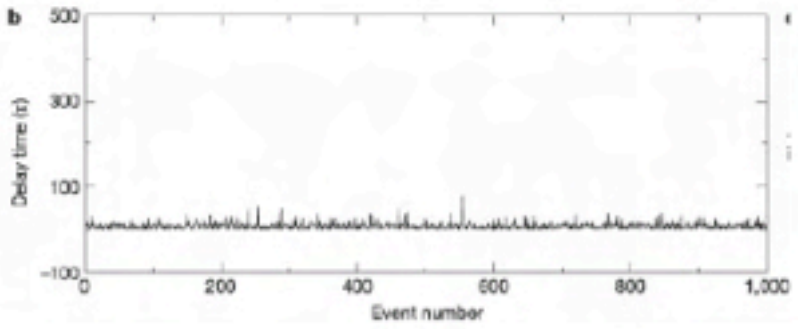
Model 2: Queueing, Bursty/Heavy Tailed

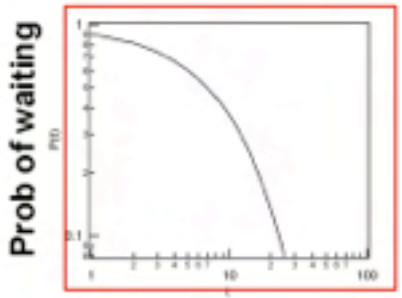


Consecutive events go through periods of intense activity followed by long pauses

Models of Human Activity

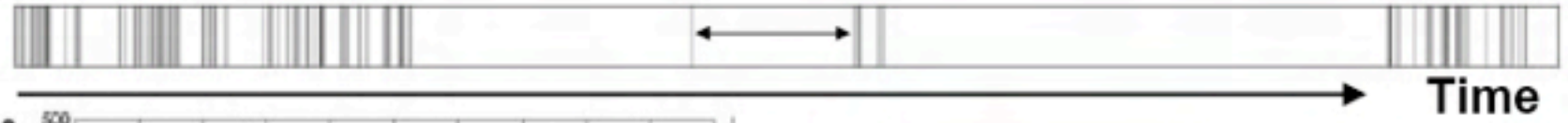
Model 1: Random

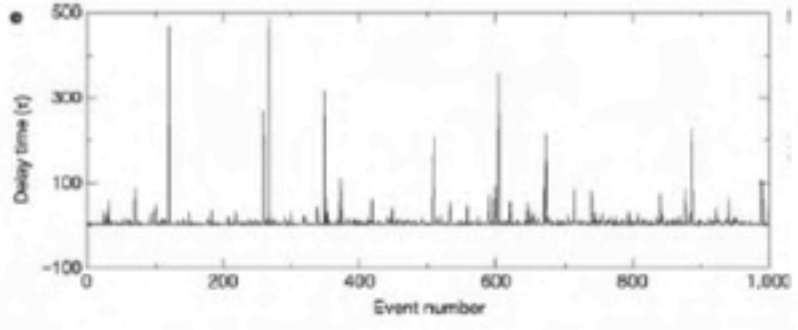


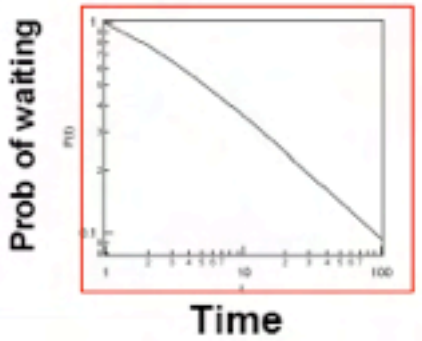


Exponential

Model 2: Bursty







Power Law

Fig: Barabasi, Nature

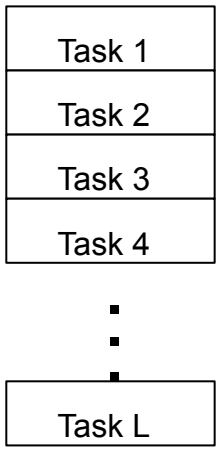
Understanding timing -- queueing models

PHYSICAL REVIEW E 77, 012101 (2008)

Power-law and exponential tails in a stochastic priority-based model queue

G. Grinstein and R. Linsker
IBM T. J. Watson Research Center, P. O. Box 218, Yorktown Heights, New York 10598, USA
(Received 18 September 2007; published 7 January 2008)

Task arrival rate: λ



Task execution rate: μ

Overburdened regime $\mu \leq \lambda$,

$$P(\tau) \sim \tau^{-3/2}$$

Highly attentive regime $\mu > \lambda$

$$P(\tau) \sim \tau^{-5/2} \exp[-(\sqrt{\mu} - \sqrt{\lambda})^2 \tau].$$

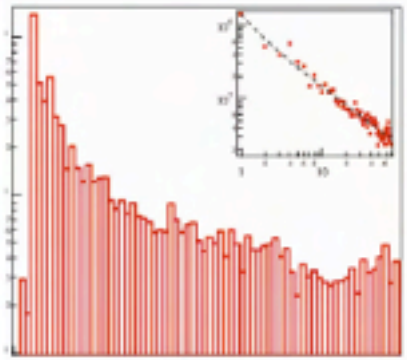
A. Saichev and D. Sornette, Effects of Diversity and Procrastination in Priority Queuing Theory: the Different Power Law Regimes, Physical Review E 81, 016108 (2009)

Typical Relaxation Dynamics

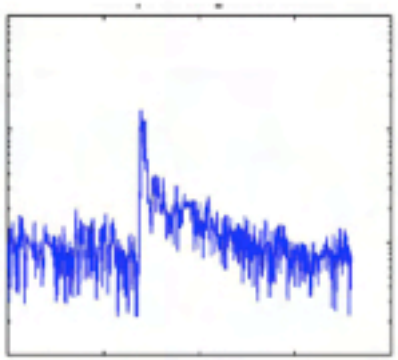
$$P(\tau) \sim \tau^{-3/2}$$

Exponents ~ 3/2

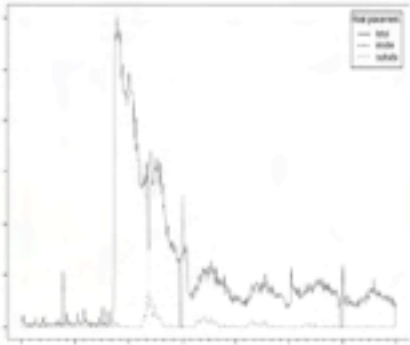
YouTube Views



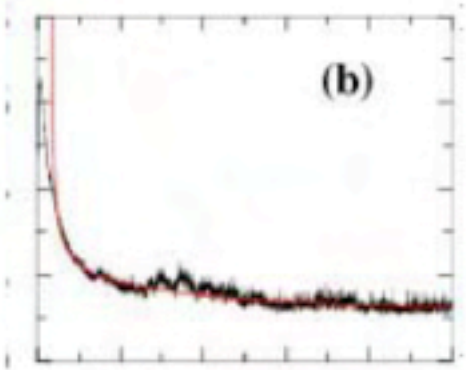
Book Sales



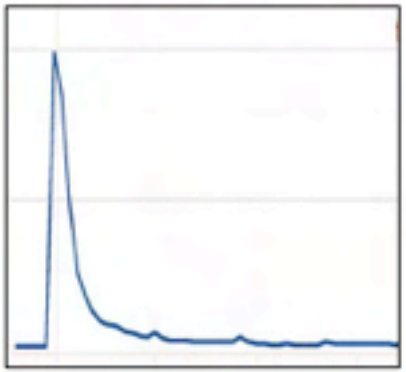
Computer Worm



Web Visitation

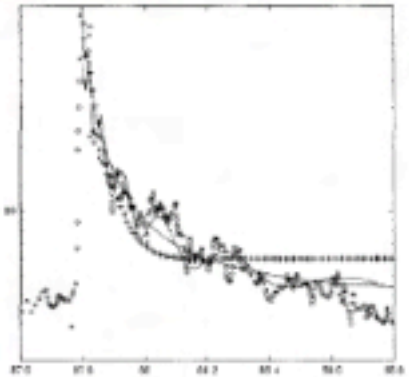


Search Queries



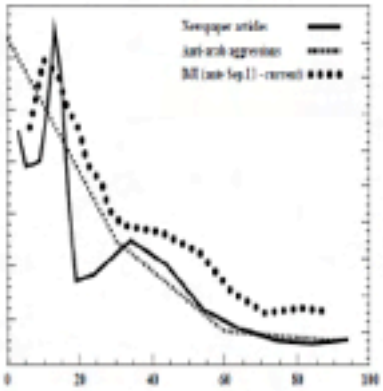
Crane etal, PNAS (2008)
Google Trends

S&P 500



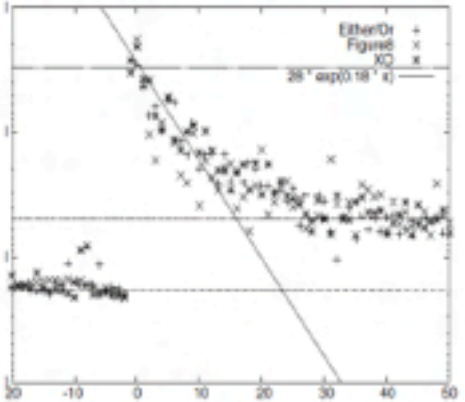
Sornette etal, PRL (2004)
Sornette etal J.Phys (1996)

September 11



Crane etal working paper (2009)
Roehner etal J.Mod.Phys (2004)

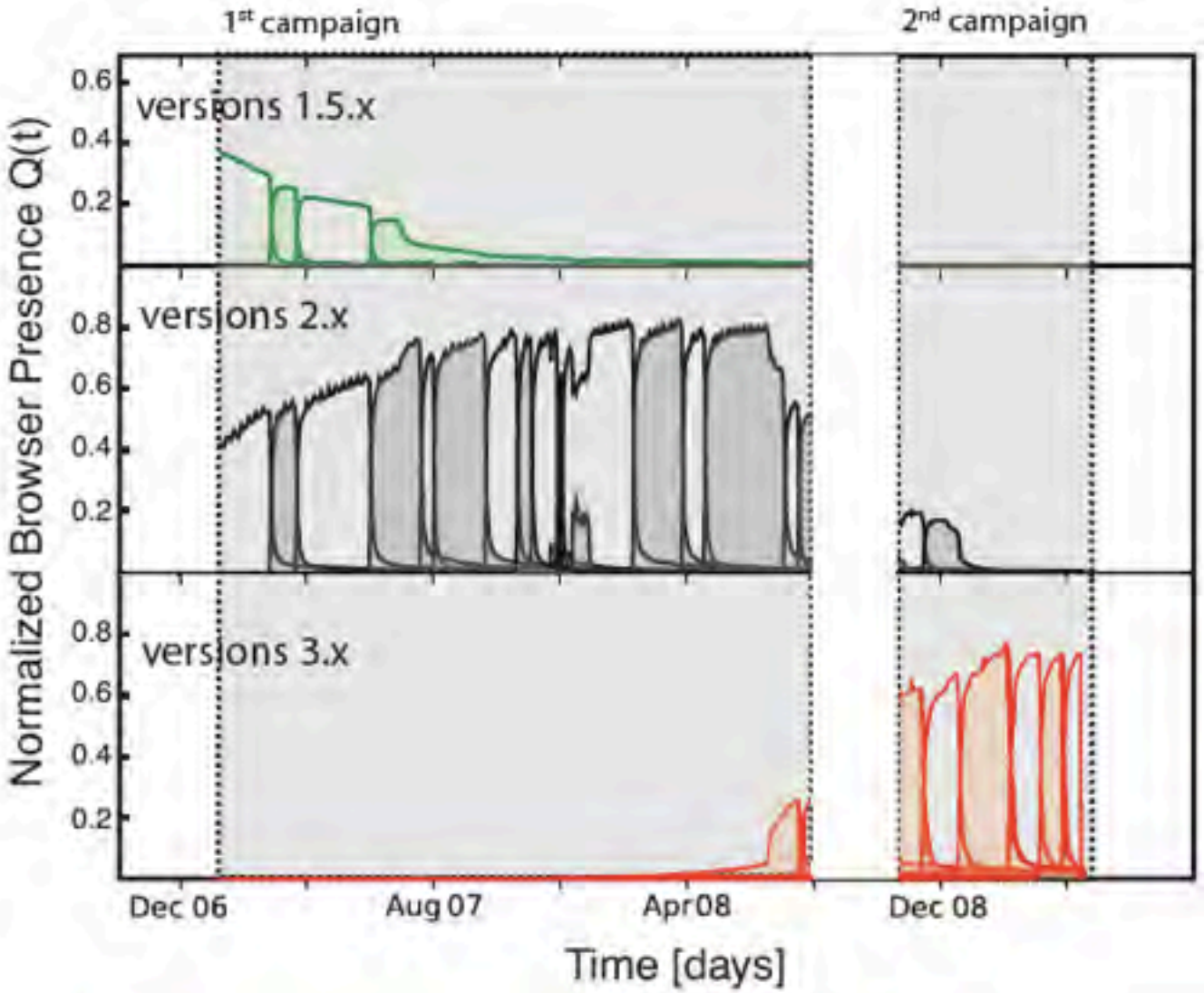
Music Sales



Dezso et al PRE (2006)
Lambiotte et al Physica A (2006)

Heavy-tail time responses in human dynamics

T. Maillart, D. Sornette, S. Frei, T. Duebendorfer, and A. Saichev



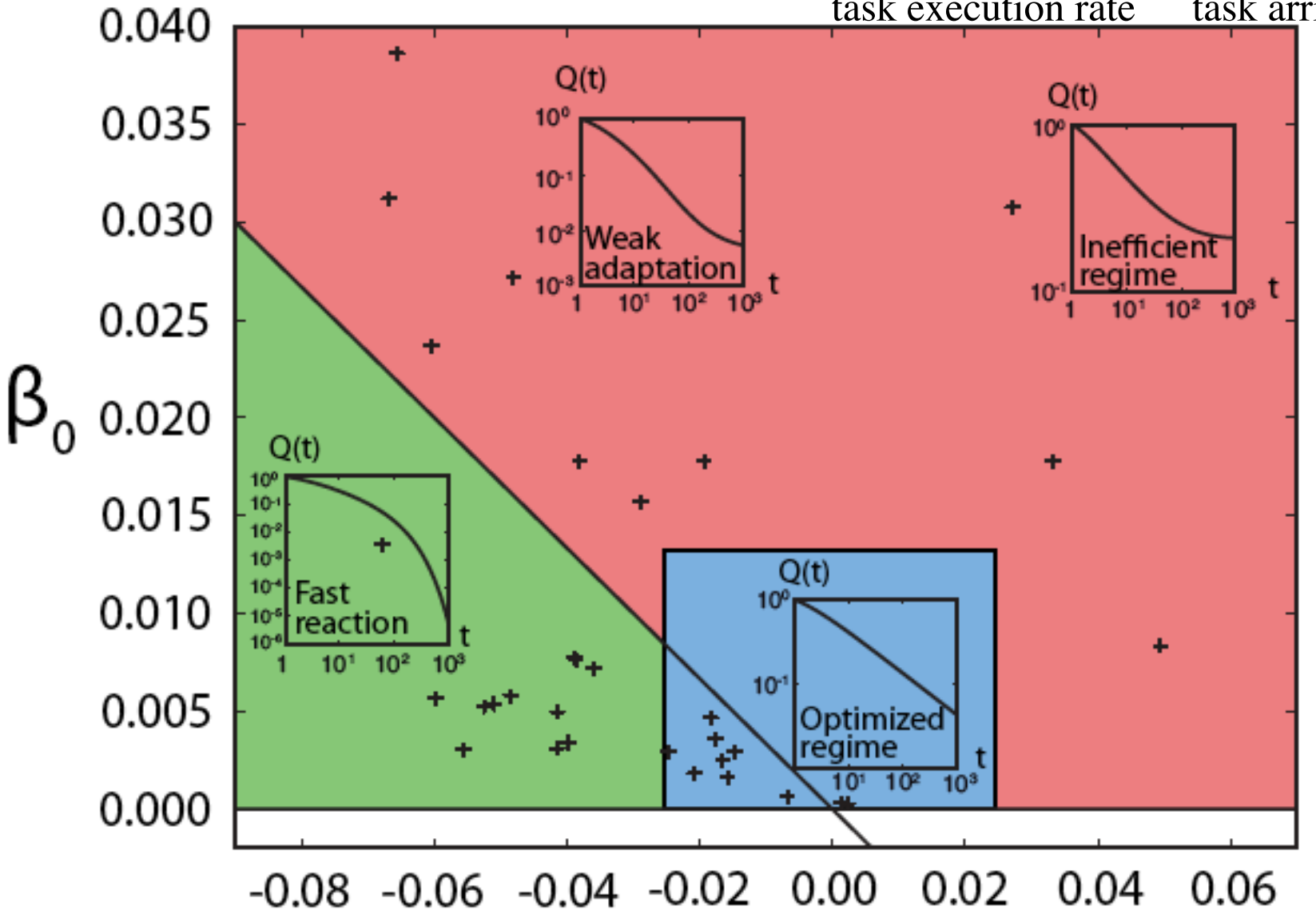
Fraction of the population using a given Mozilla Firefox browser (minor) version as a function of time and over two data collection campaigns. The three major versions 1.5.x, 2.x and 3.x are shown separately.

Persistence of the use of outdated Web browsers (Firefox, Opera, Chrome and Safari) after users have been prompted to perform an update. Our data is obtained from anonymized daily log files of Google web servers (more than 70% of the worldwide daily searches), collected over more than three years.

std of the time deficit

$$\beta = \mu - \lambda$$

task execution rate task arrival rate



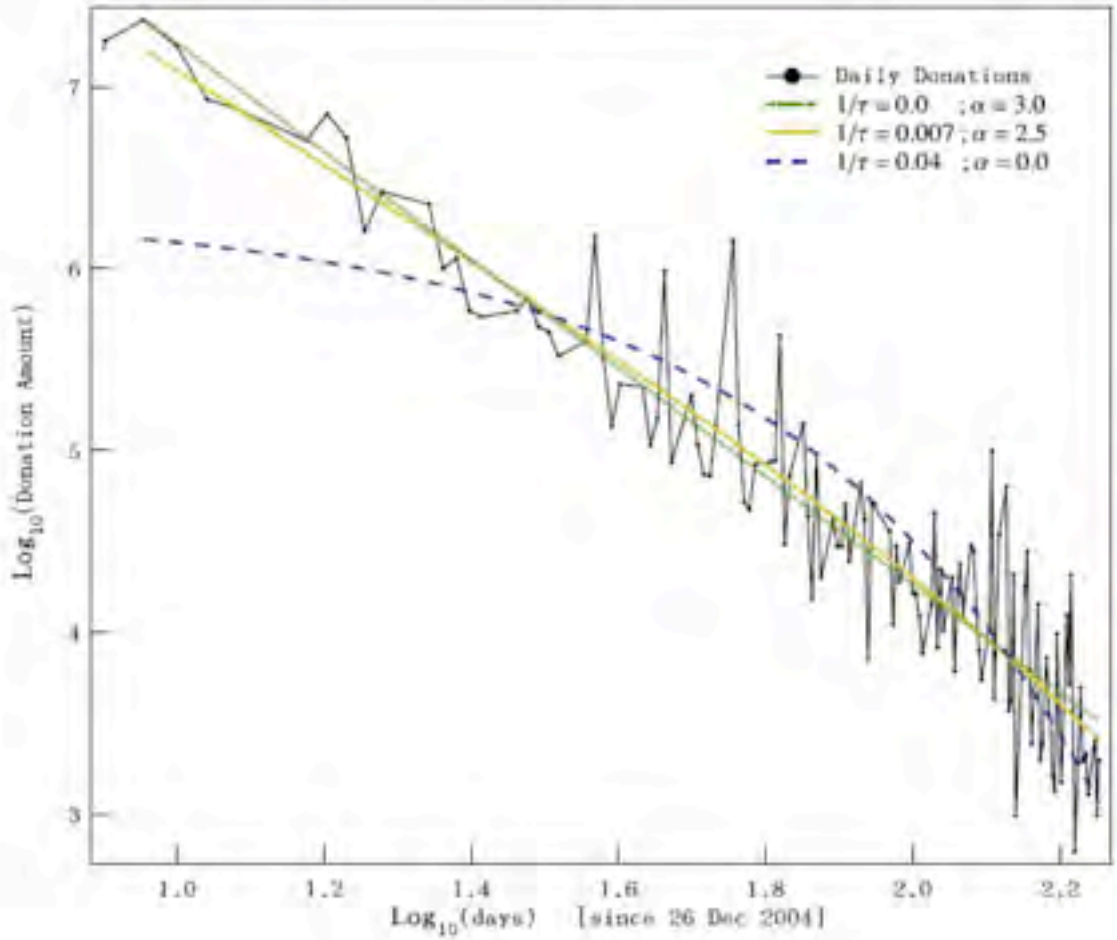
Thomas Maillart, Didier Sornette, Stefan Frei, Thomas Duebendorfer and Alexander Saichev, Quantification of deviations from rationality from heavy-tails in human dynamics, in press in Phys. Rev. E (2011) (arxiv.org/abs/1007.4104)

$\overline{\beta}$: average time deficit

Donation response to tsunami

Highly attentive regime $\mu > \lambda$

$$P(\tau) \sim \tau^{-5/2} \exp[-(\sqrt{\mu} - \sqrt{\lambda})^2 \tau].$$



Pure exponential

$$D(t) = e^{-\frac{t}{\tau}}$$

Pure power law

$$D(t) = \frac{A}{t^{\alpha}}$$

Power law w/exponential tail

$$D(t) = \frac{A}{t^{\alpha}} e^{-\frac{t}{\tau}}$$

Applications: Signatures of media exposure?

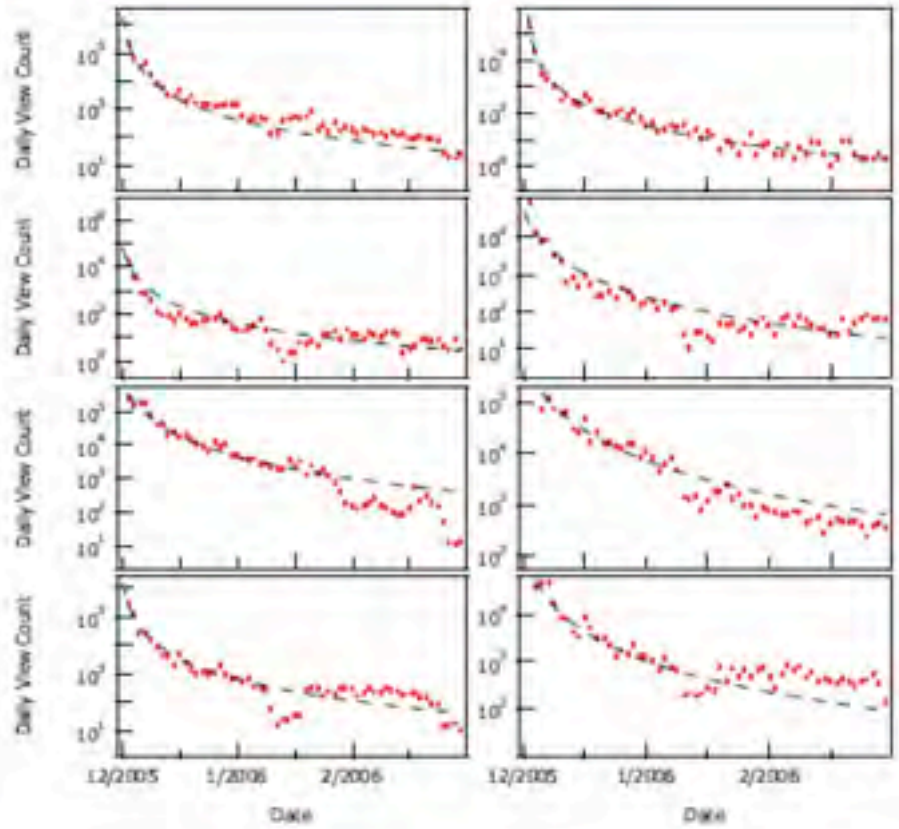


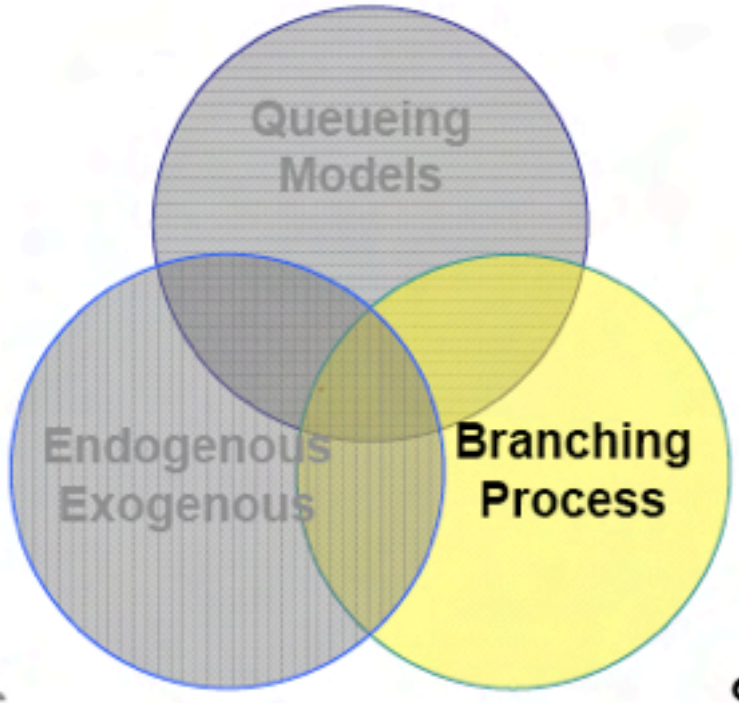
FIG. 3: Eight log-lin plots showing the dynamics of the videos related to the execution of Saddam Hussein. Fits to each dataset are shown as a dashed line and described by a power law relaxation with an exponent in the range $2.4 \leq \alpha \leq 2.6$.

New Power Law Signature of Media Exposure in Human Response Waiting Time Distributions

R. Crane, F. Schweitzer and D. Sornette, New Power Law Signature of Media Exposure in Human Response Waiting Time Distributions, Physical Review E 81, 056101 (2010)

Disentangling the pieces

Individual Activity → Power law distribution of waiting times



Nature of Bursts

Epidemic Spreading

Models of epidemics

Imitation

-Imitation is considered an efficient mechanism of social learning.

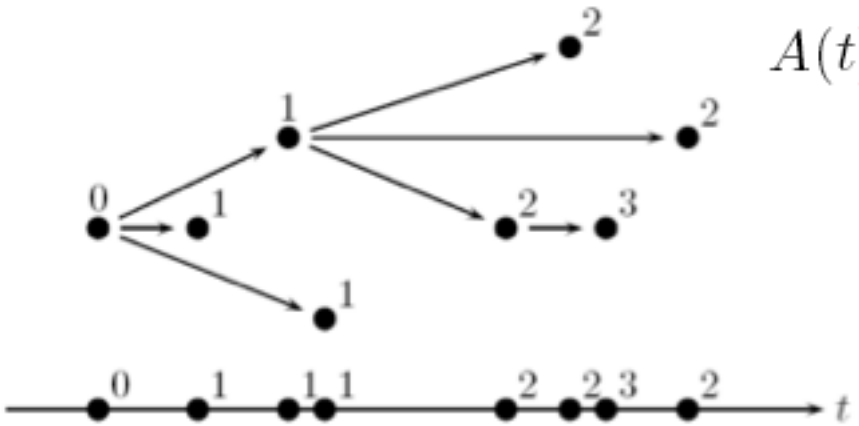
- Experiments in developmental psychology suggest that infants use imitation to get to know persons, possibly applying a 'like-me' test ('persons which I can imitate and which imitate me').

- Imitation is among the most complex forms of learning. It is found in highly socially living species which show, from a human observer point of view, 'intelligent' behavior and signs for the evolution of traditions and culture (humans and chimpanzees, whales and dolphins, parrots).

- In non-natural agents as robots, tool for easing the programming of complex tasks or endowing groups of robots with the ability to share skills without the intervention of a programmer. Imitation plays an important role in the more general context of interaction and collaboration between software agents and human users.

Epidemic branching process

The activity is modeled as a self-excited Hawkes conditional Poisson branching process



$$A(t) \equiv \langle \lambda(t) \rangle = \eta(t) + n \int_{-\infty}^{t} \phi(t-\tau) A(\tau) d\tau$$

$$A(t) = \eta(t) + \int_{0}^{t} \eta(\tau) K(t-\tau)\, d\tau$$

Helmstetter and Sornette, Physica A (2003)

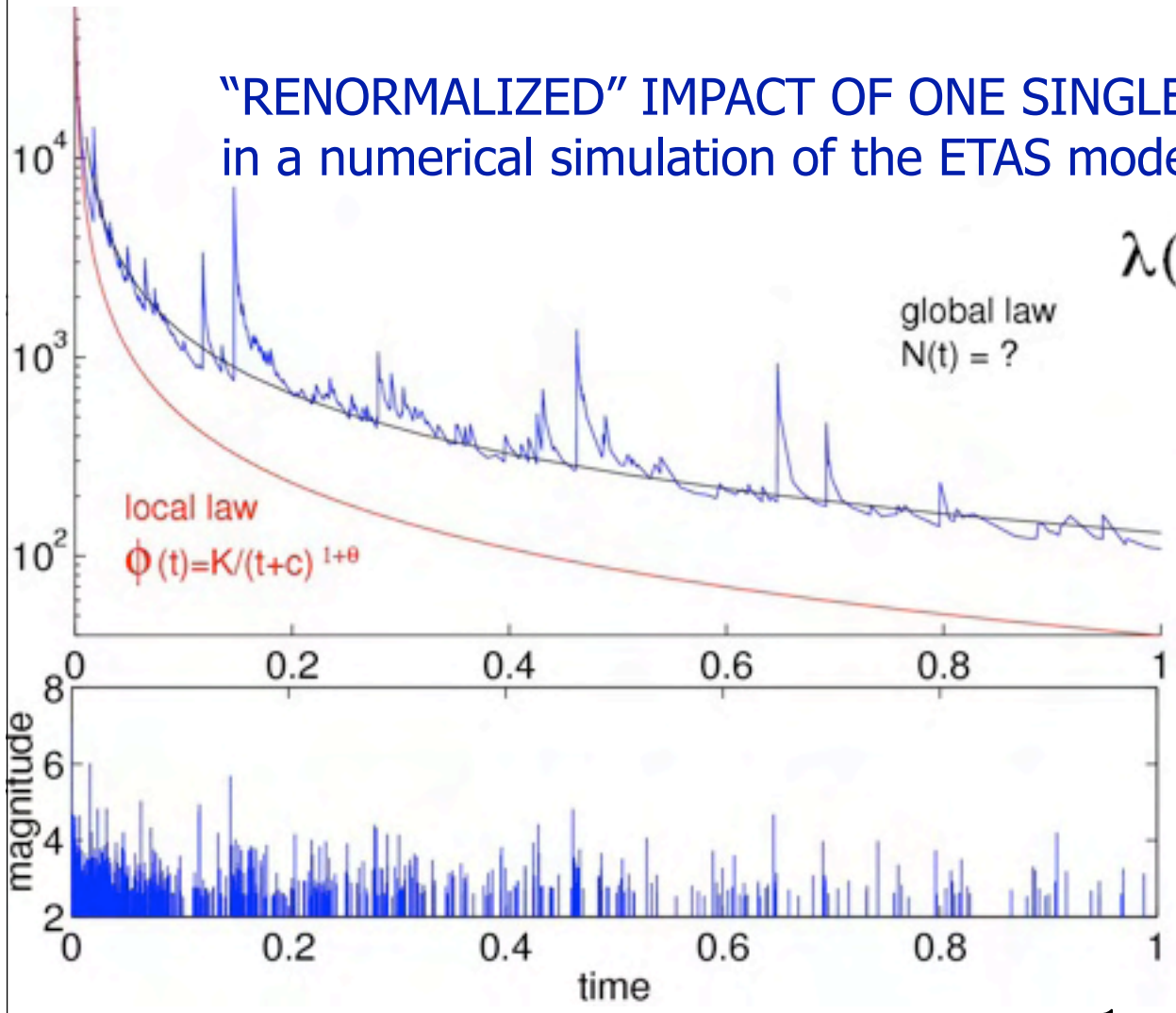
Key Results:

Bare response	$A(t) \sim 1/(t-t_c)^{1+\theta}$
Exo Critical response	$A(t) \sim 1/(t-t_c)^{1-\theta}$
Endo critical response	$A(t) \sim 1/\lvert t-t_c \rvert^{1-2\theta}$

Hawkes ETAS model and numerical simulations

The impact of cascades of generations

"RENORMALIZED" IMPACT OF ONE SINGLE PIECE OF INFORMATION
in a numerical simulation of the ETAS model

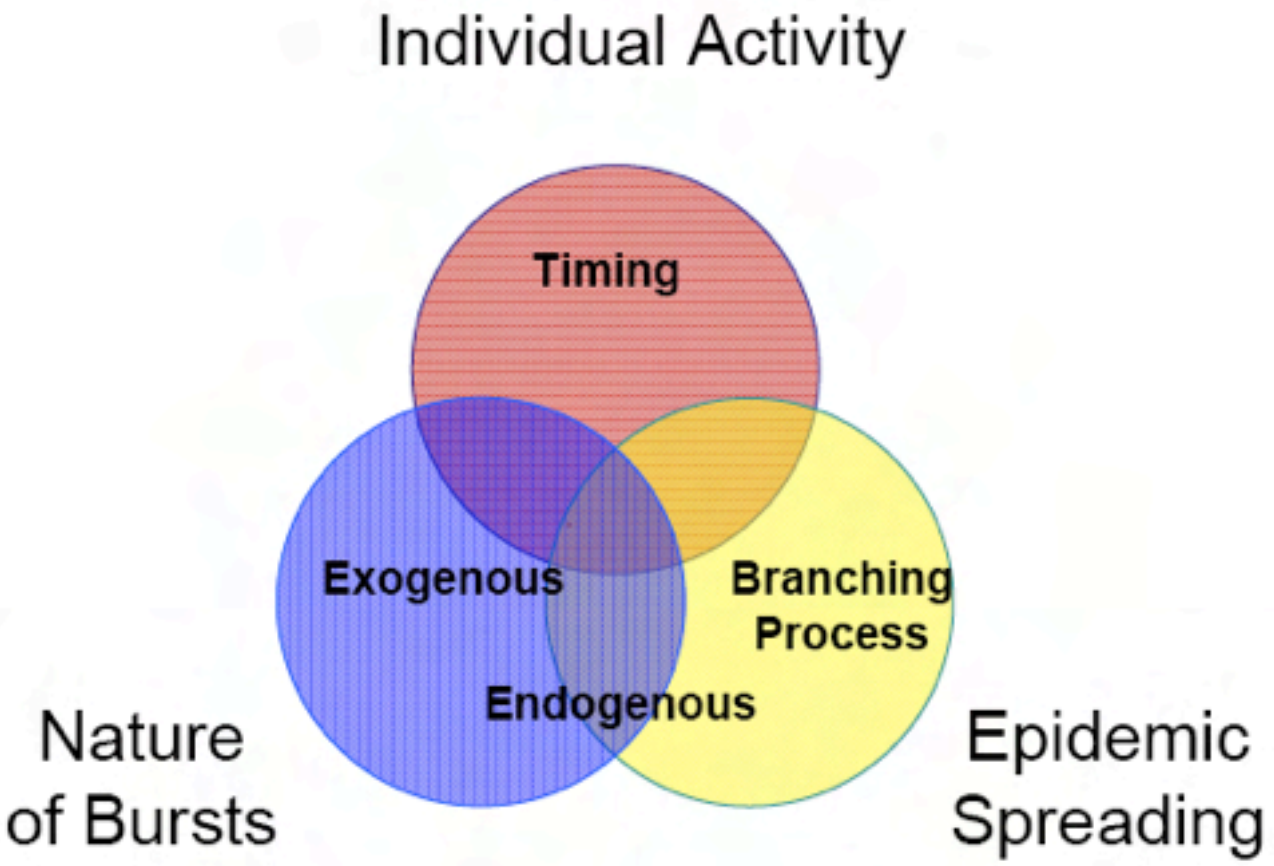


$$\lambda(t) = \eta(t) + \sum_{i|t_i \le t} \mu_i \phi(t - t_i)$$

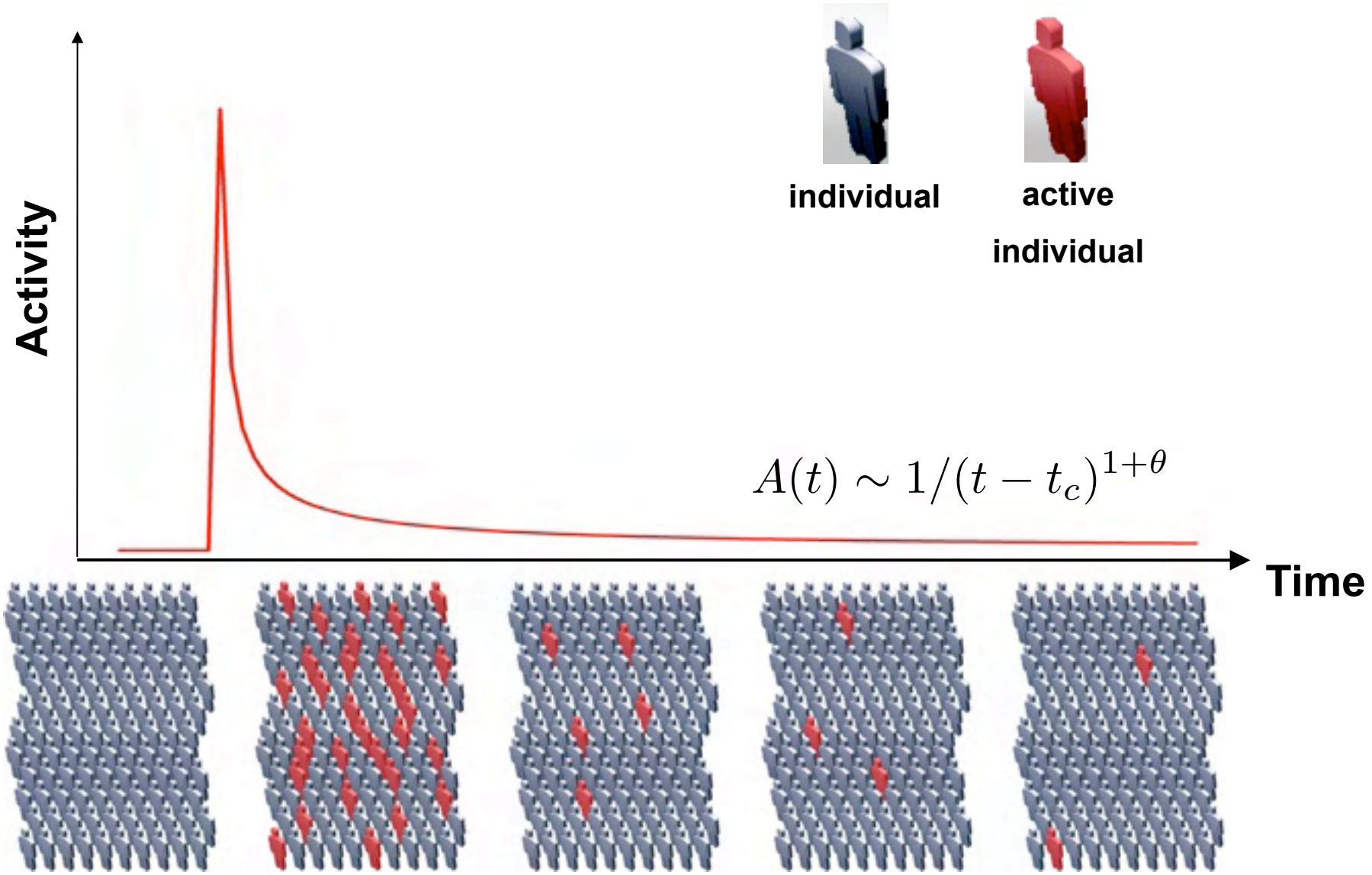
$$\phi(t) \sim 1/t^{1+\theta}$$

For $\phi \sim 1/t^{1+\theta}$ $\quad S_{exo} \equiv K(t) \sim \dfrac{1}{t^{1-\theta}}$ $\quad$ with $\quad 0 < \theta < 1$

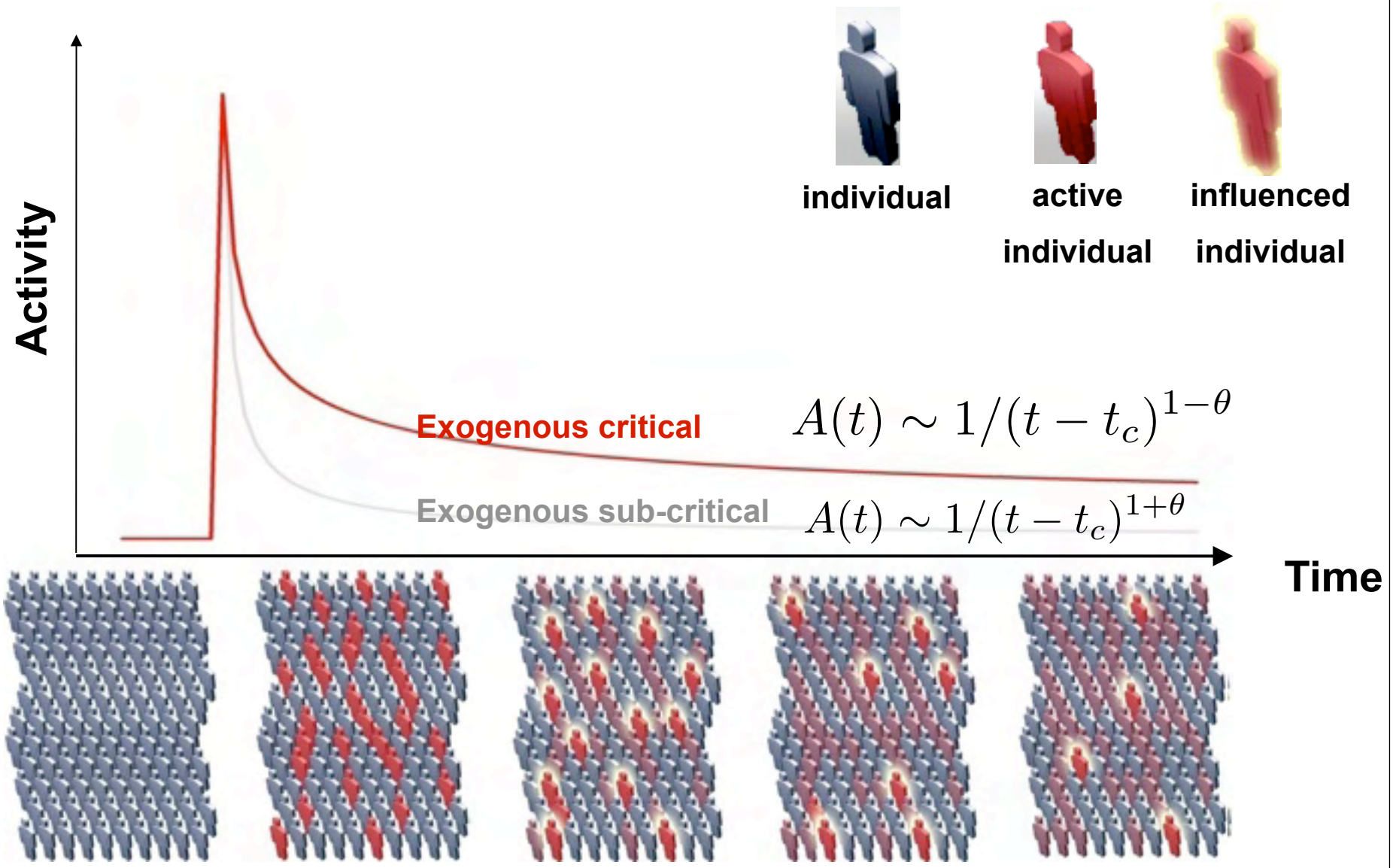
Self-excited epidemics



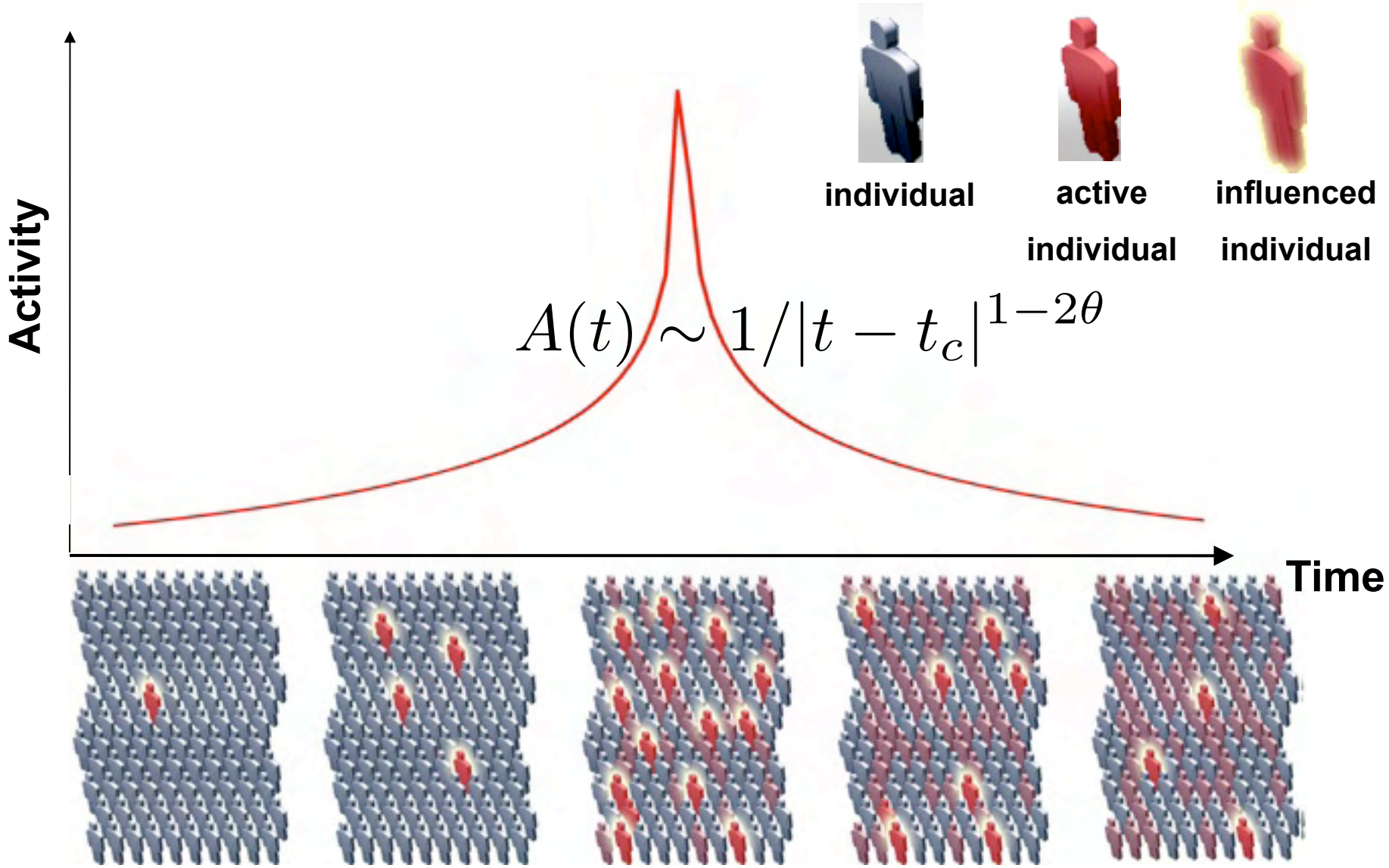
Exogenous sub-critical (no spreading)



Exogenous critical (spreading)

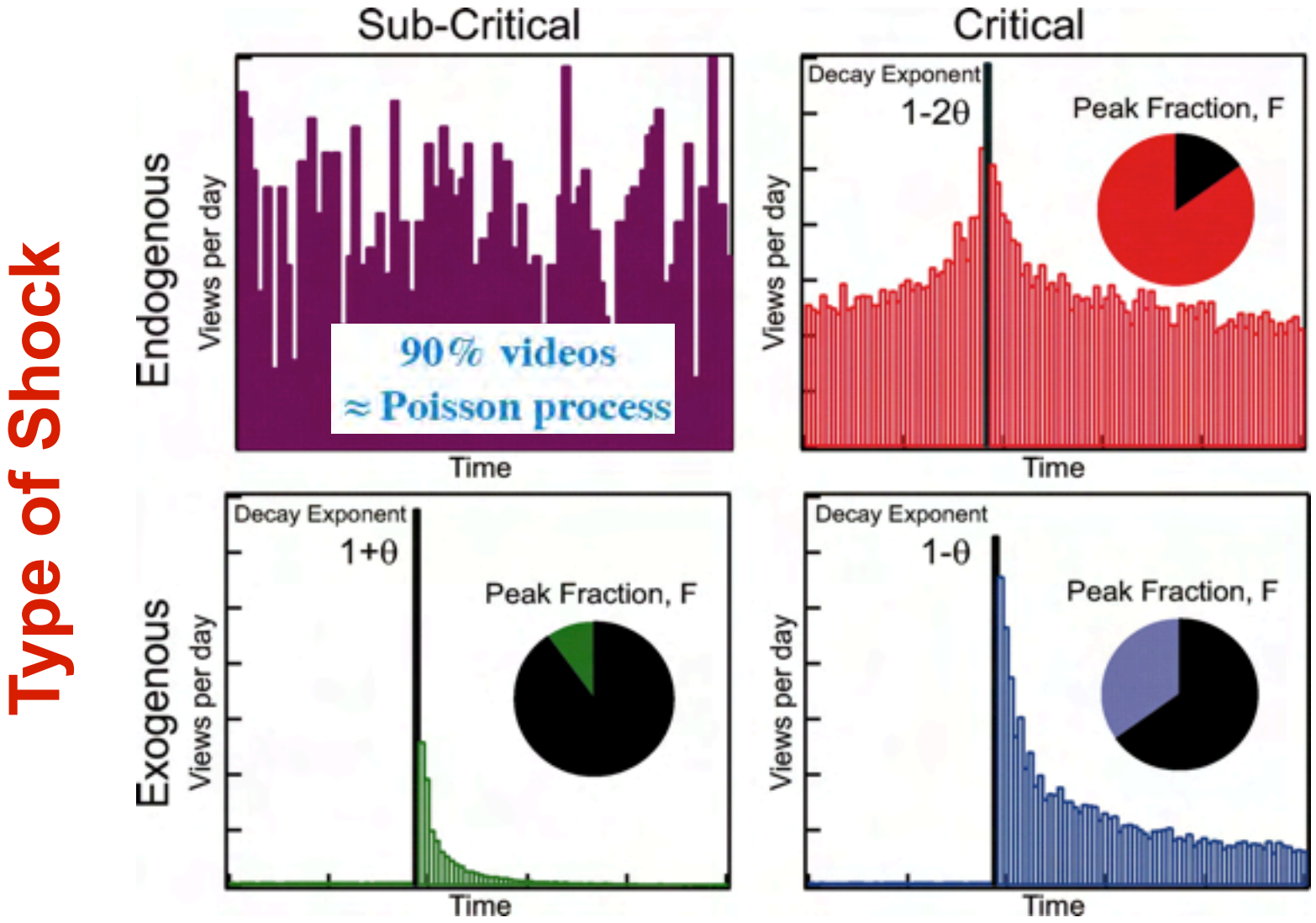


Endogenous critical (spreading)

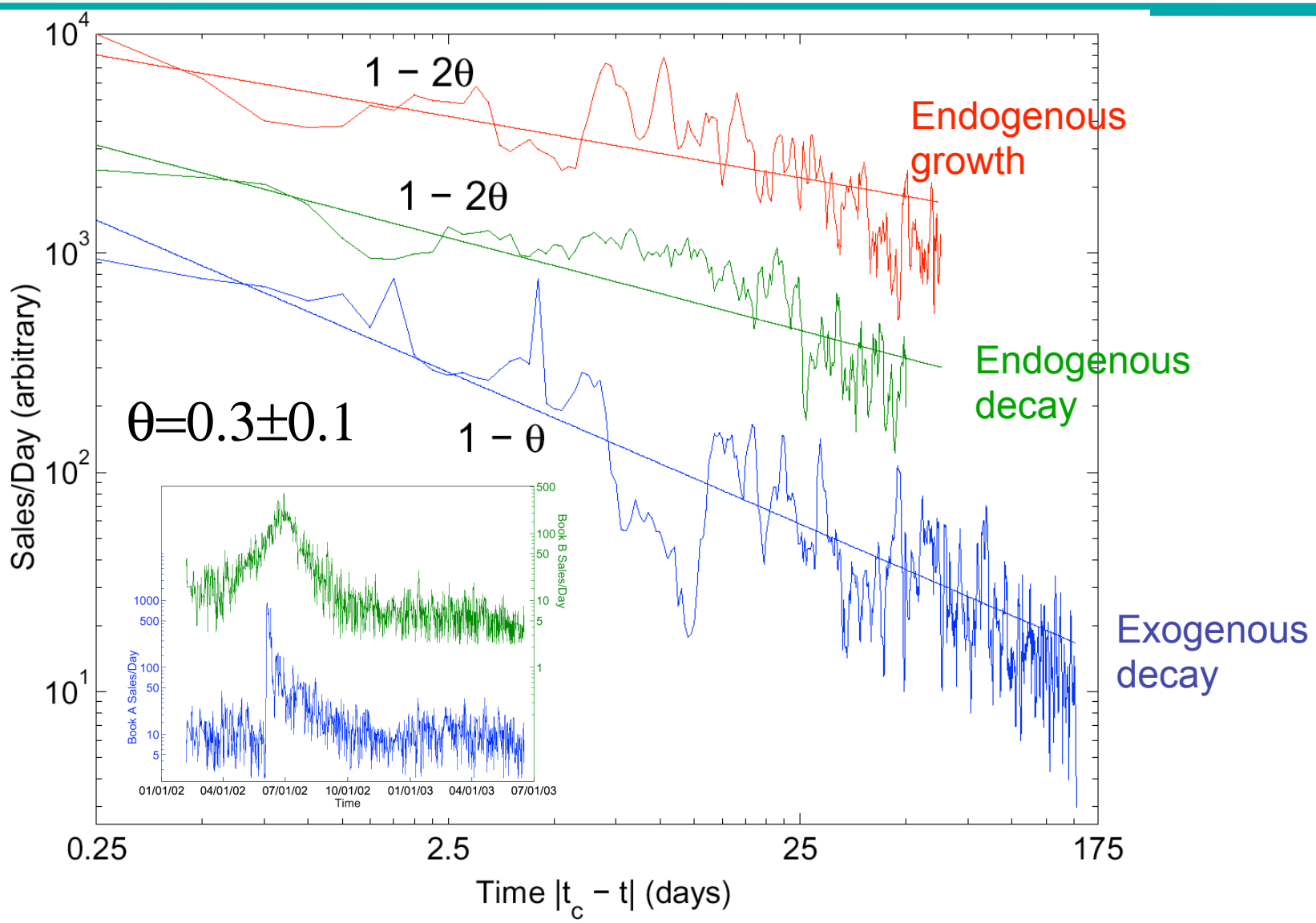


Predicted activity patterns

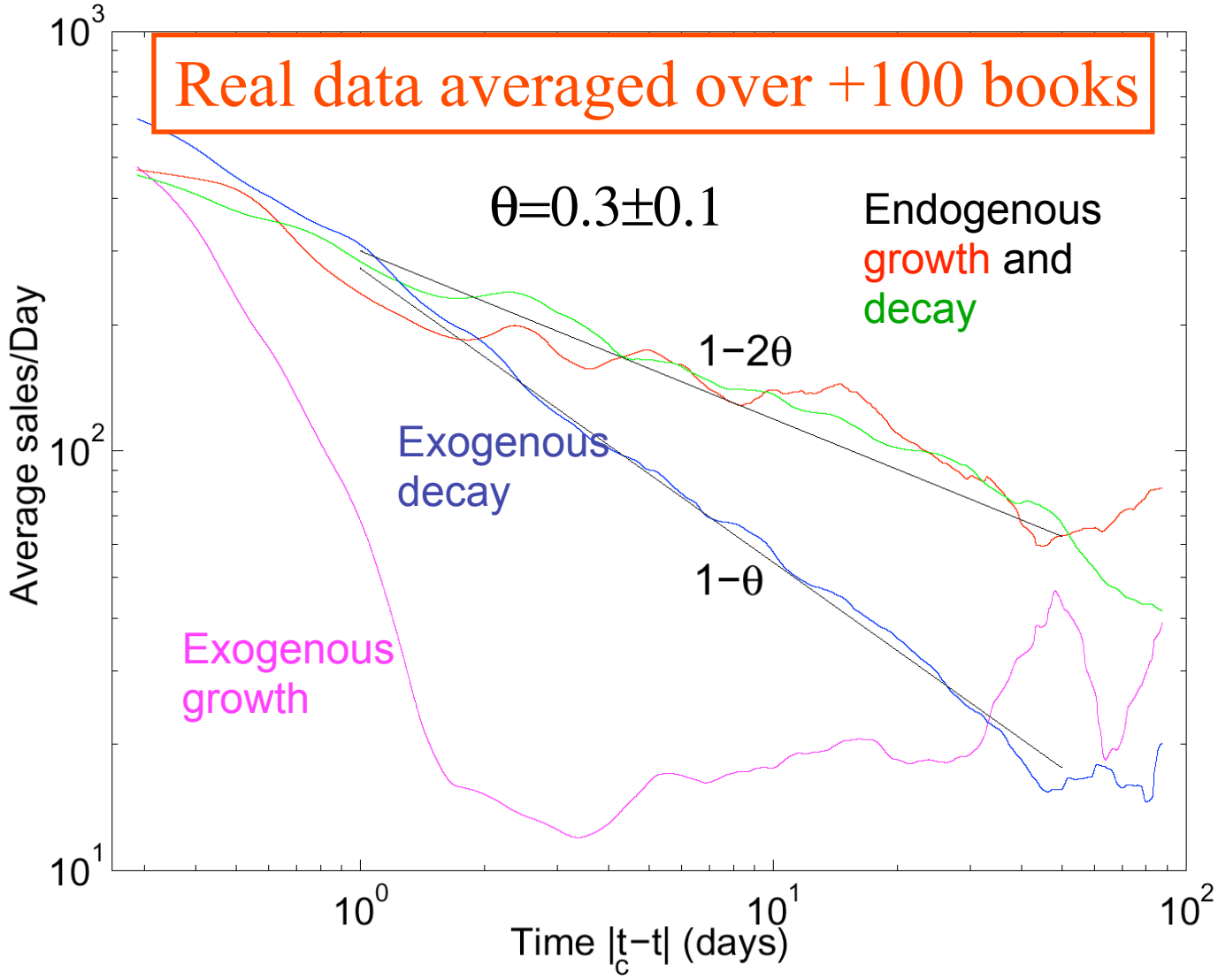
Crane, R and Sornette, D., *PNAS* (2008)



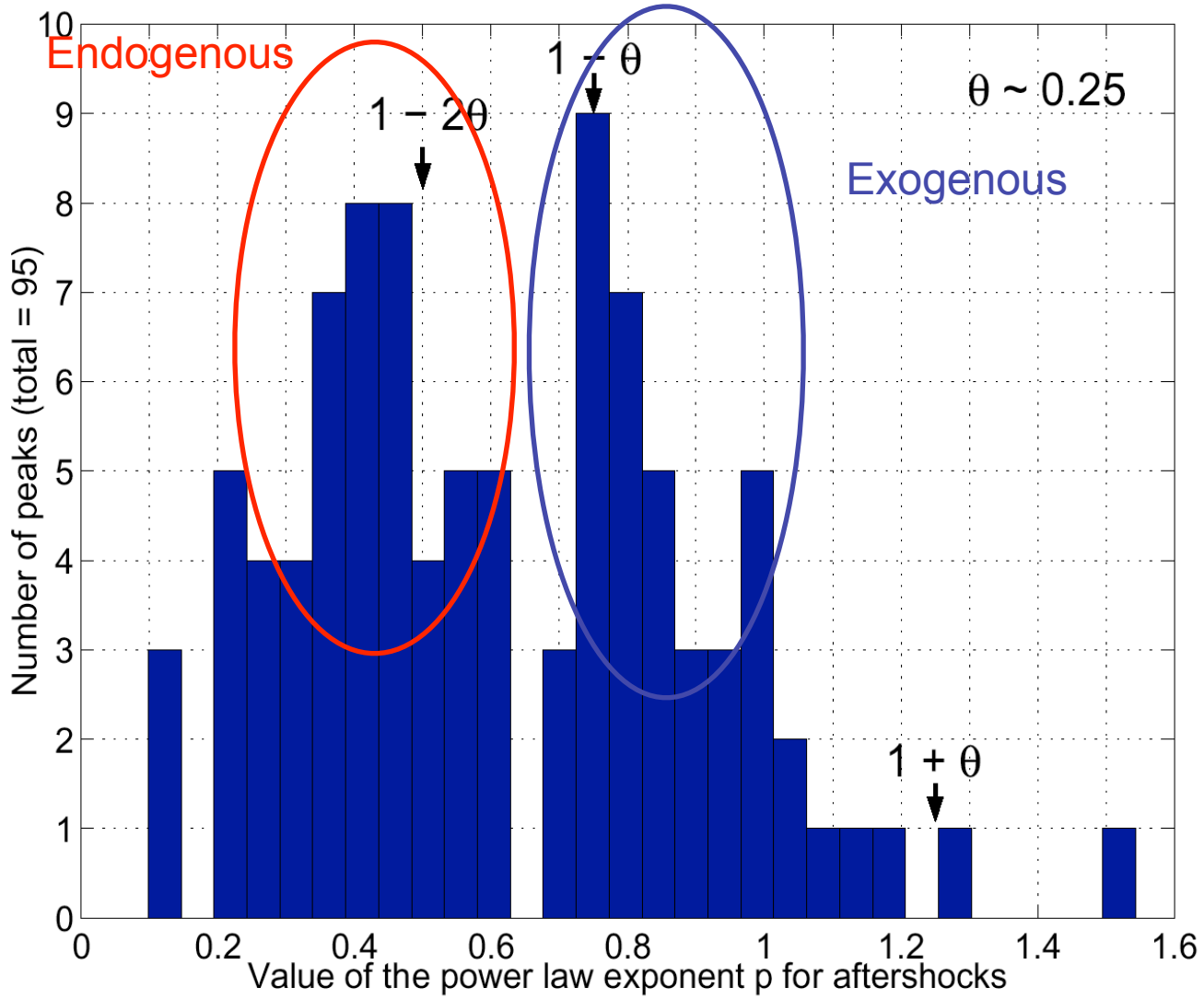
Single Book Analysis



The Aggregate



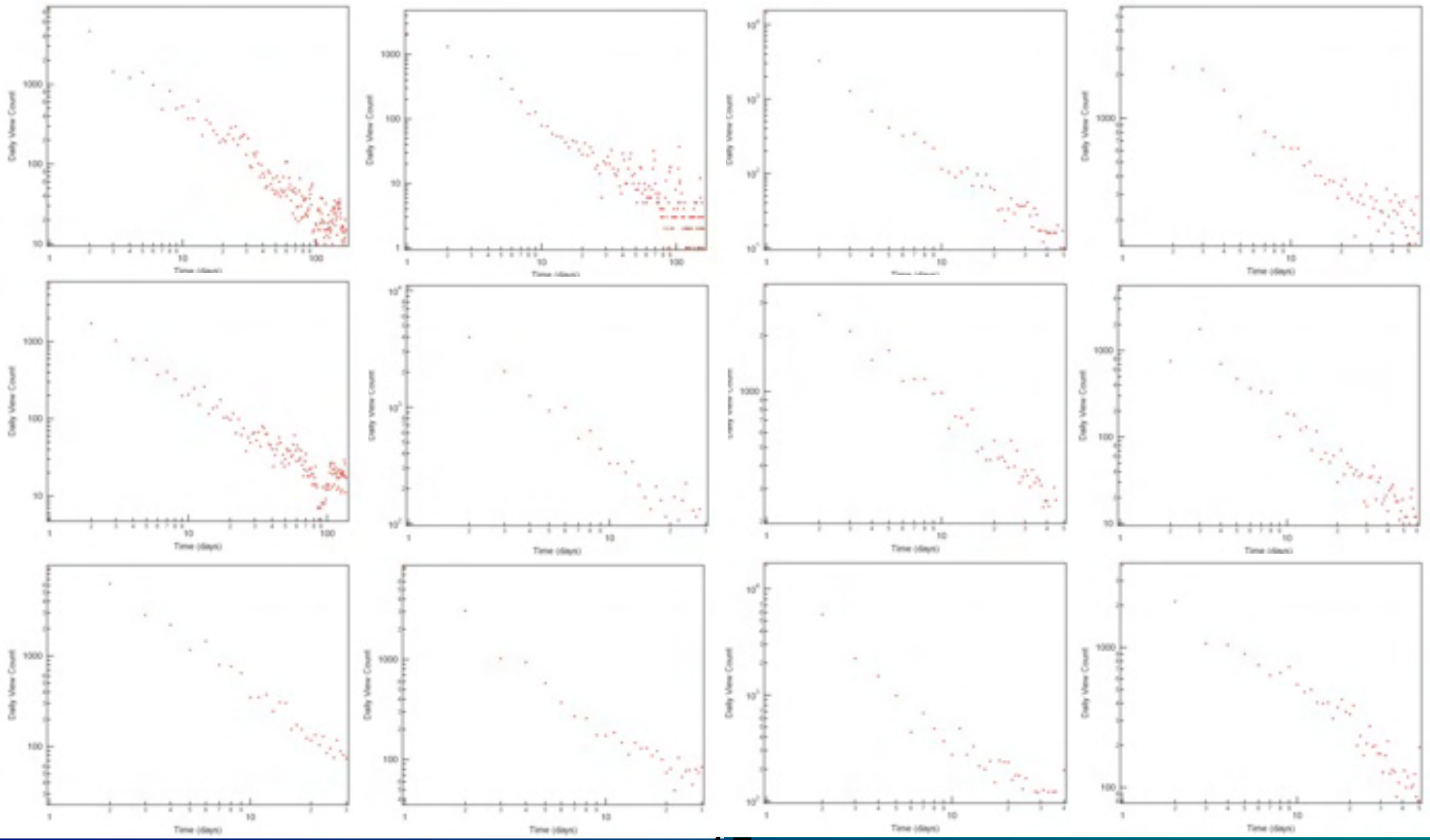
Histogram of Exponents



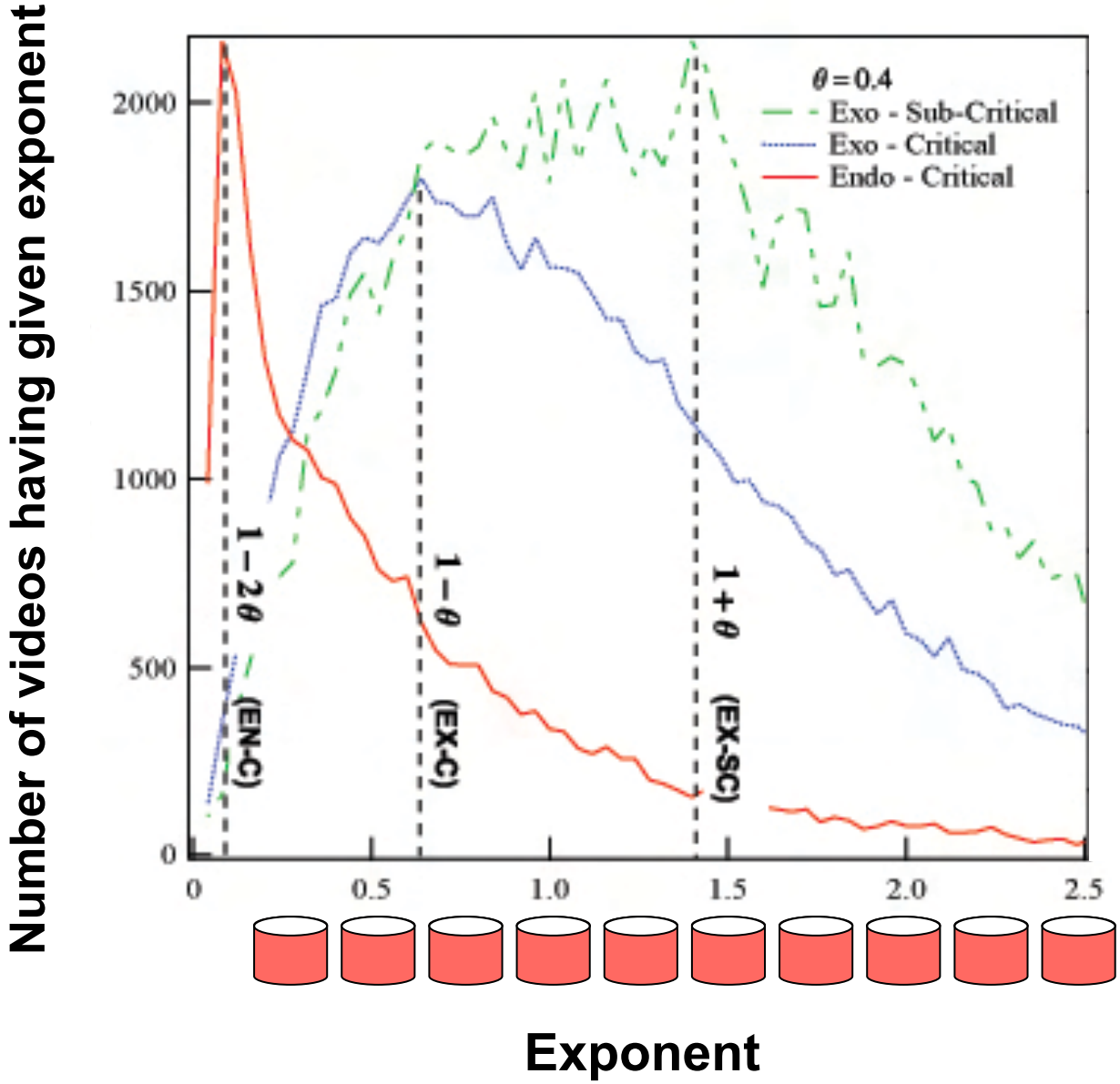
A Shocking Look At...

Riley Crane, Didier Sornette
ETH Zurich, D-MTEC
Chair of Entrepreneurial Risks

Typical Relaxation after a burst of activity

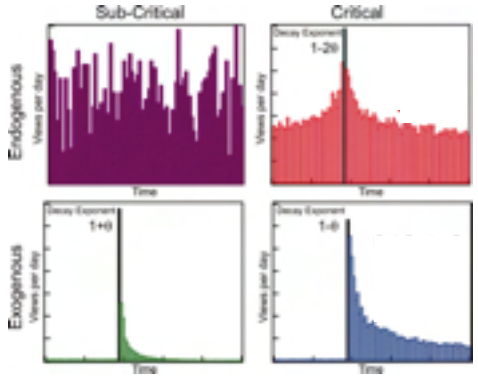


Results: Classifying Relaxation



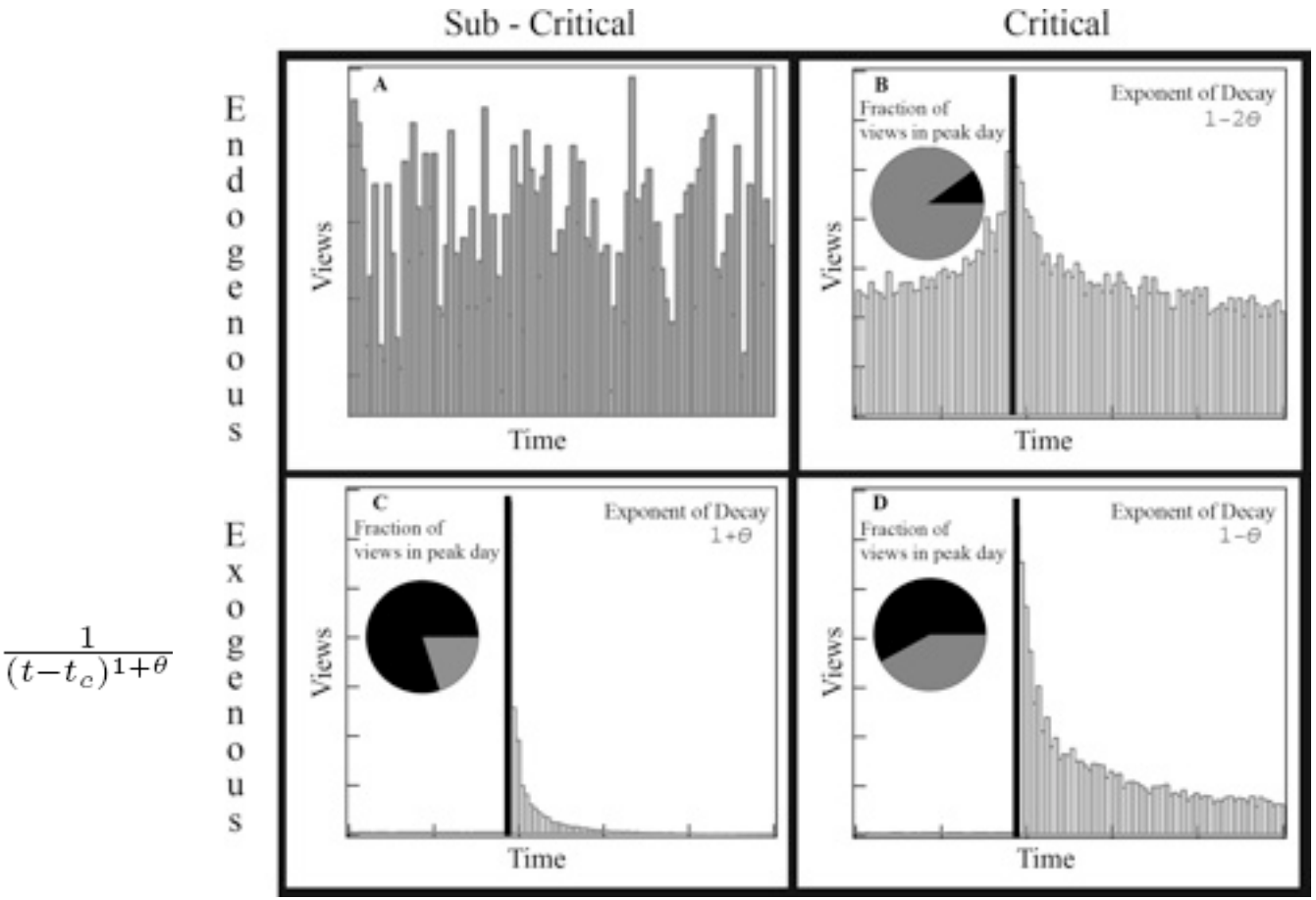
1. Class 1 is defined by $80\% \leq F \leq 100\%$.
2. Class 2 is defined by $20\% < F < 80\%$.
3. Class 3 is defined by $0\% \leq F \leq 20\%$.

Class 1 $\longleftrightarrow$ Exogenous subcritical
Class 2 $\longleftrightarrow$ Exogenous critical
Class 3 $\longleftrightarrow$ Endogenous critical.



Crane et al, PNAS (2008)

Predictions of the model

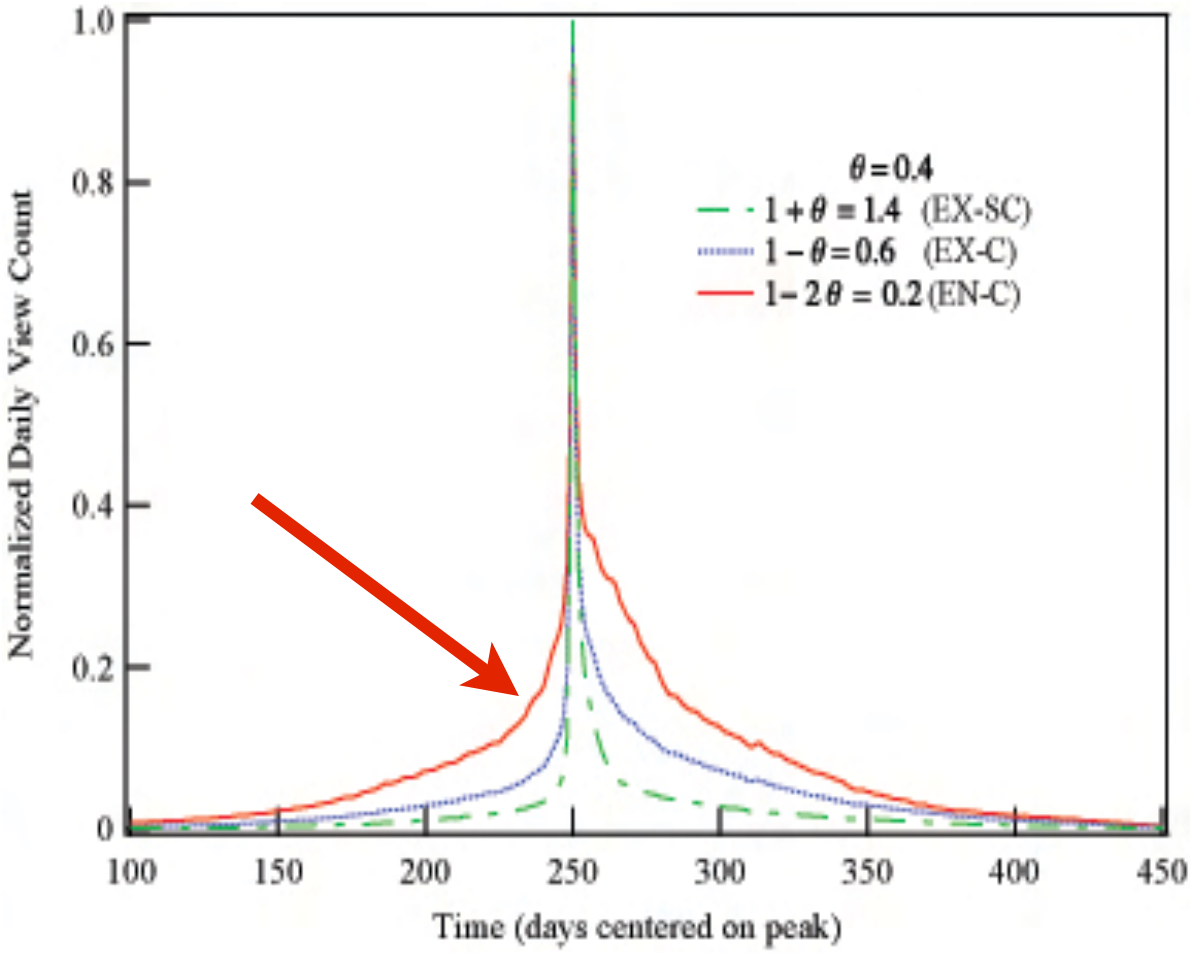


$\frac{1}{|t-t_c|^{1-2\theta}}$

$\frac{1}{(t-t_c)^{1+\theta}}$

$\frac{1}{(t-t_c)^{1-\theta}}$

What about precursory information?



Predicting the rise and fall of social and economic interactions by monitoring and modeling internet activities and commercial sales

- Book, CD music sales…
- Internet searches
- Recommendation Blogs
- Open source software projects
- Ethical Hacking security
- NATO (National Association of Theatre Owners)

Dynamics of Success in Open Source Software

A Collective Action Perspective

SOURCEFORGE

OpenOffice.org

Linux

APACHE

with Thomas MAILLART (ETH Zurich)

Uncover Epidemics in OSS

- Dynamics of committers activity is analyzed for
  - Mozilla
  - Eclipse (data provided by University of Zurich)

s.e.a.l. University of Zurich Department of Informatics

- CVS (concurrent versioning system)
  - all activity has been recorded over projects lifetime (~8 years)
  - (almost) no possible bias

- Phenomenological approach
  - dynamics of commits
  - interplay between developers
  - relation between generations of developers

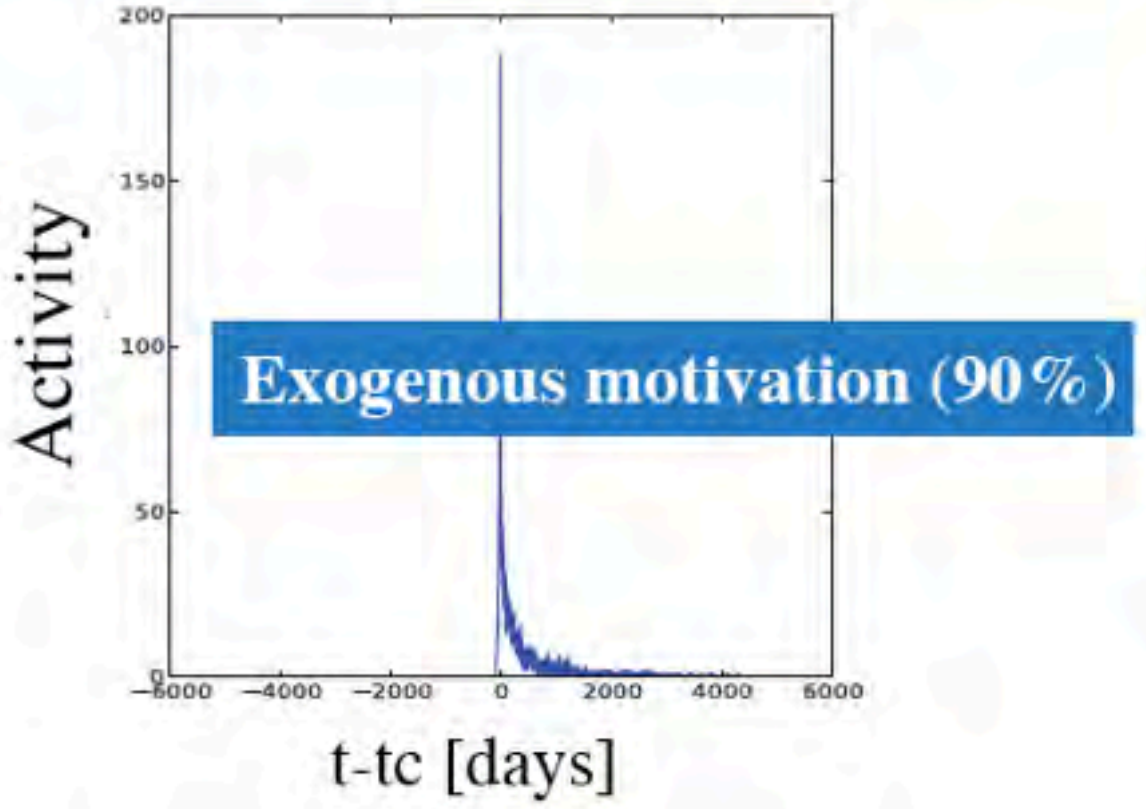
Source Code Dependencies

(with Thomas MAILLART, ETH Zurich)

Collective Behaviors

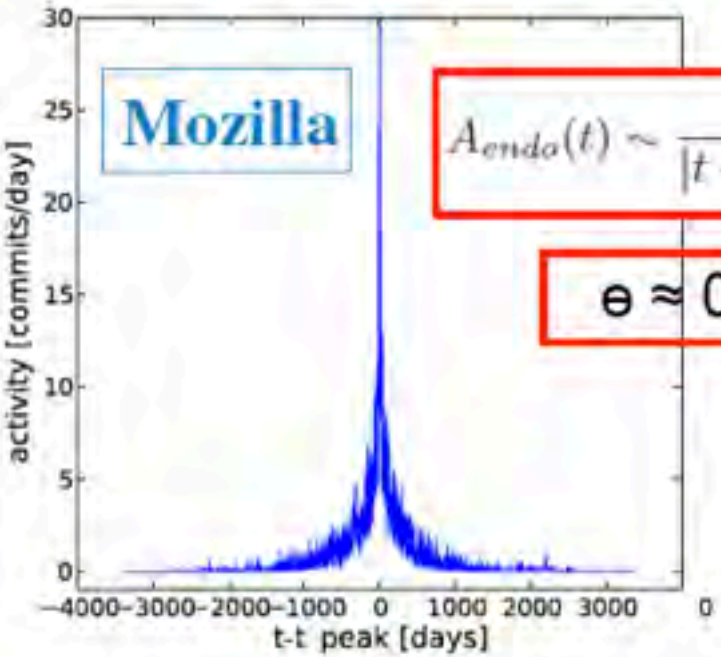
in the Software Sphere

Individual patterns similar to those in the information sphere !



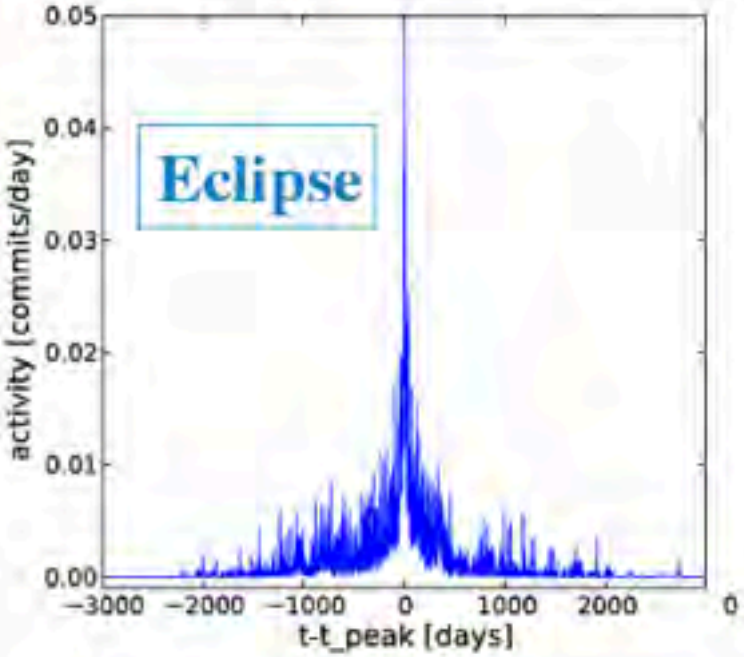
H0 : Individual Self-reinforcing Process

- Method
  - Set the “peak activity” to t=0, for all developers
  - Build statistical activity by averaging activity over all coders



$$A_{endo}(t) \sim \frac{1}{|t - t_c|^{1-2\theta}}$$

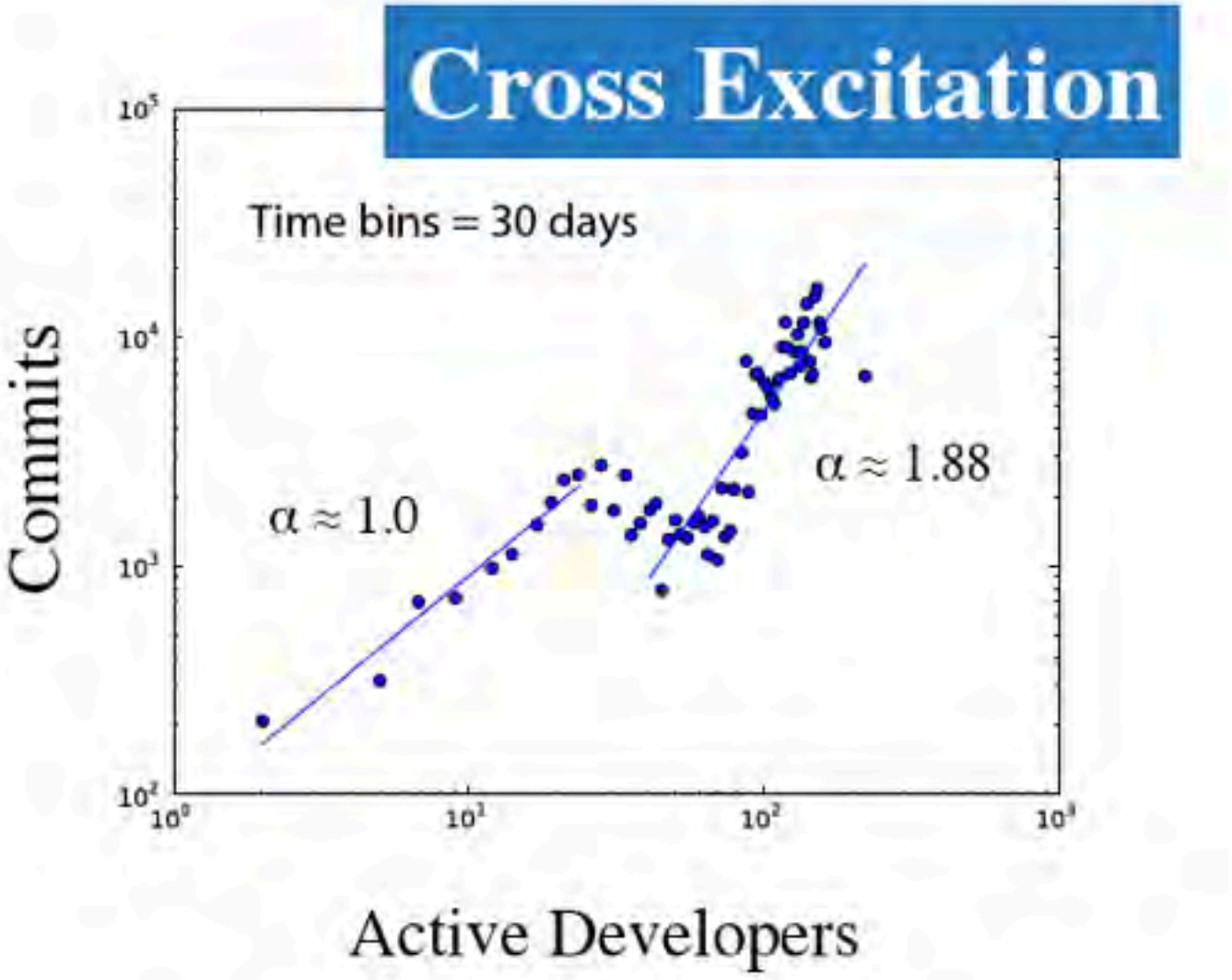
$\theta \approx 0.3$



➡ Endogenous regime of developers activity

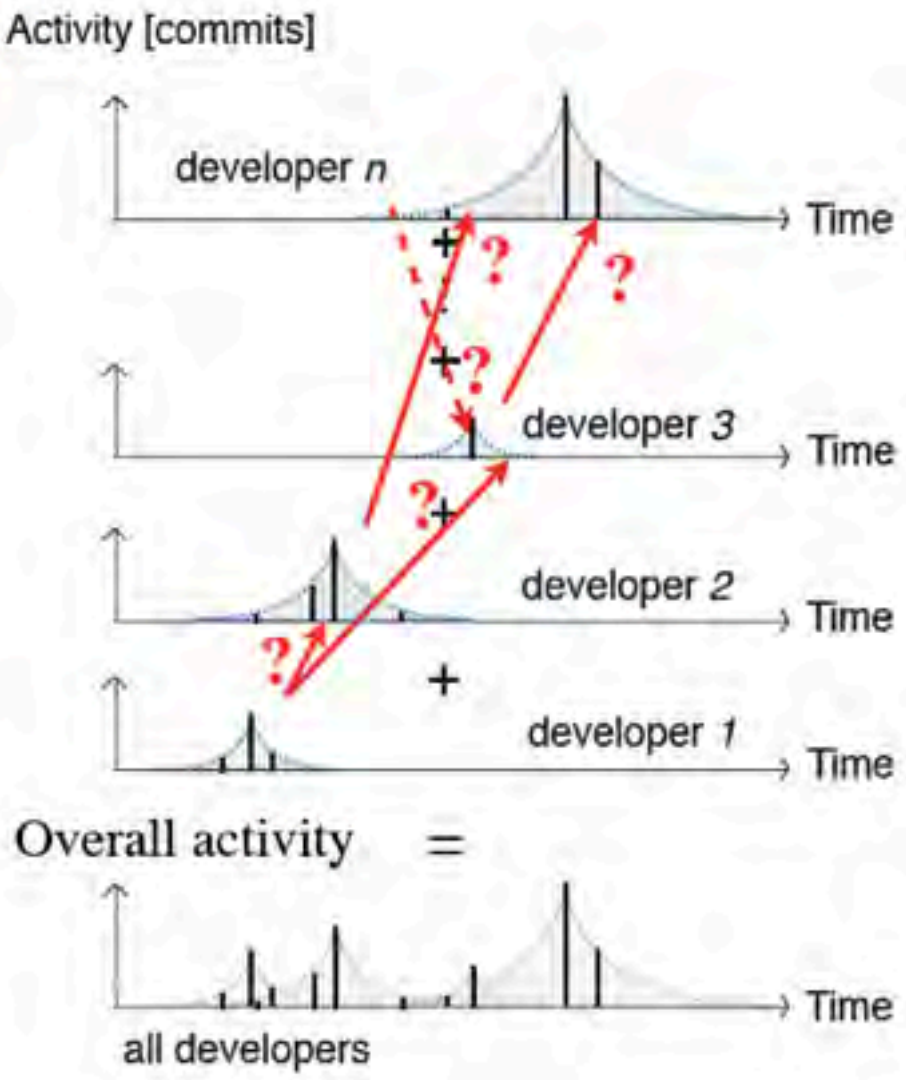
with Thomas MAILLART (ETH Zurich)

Collective Behaviors
in the Software Sphere



H1: Collective Action

- Is there a relation (self. reinforcing process) between developers?
- The peak size determines (on average) the span of developers activity over time
  - small peak => short contribution
  - large => long contribution
- To test for memory and triggering effects between developers, it is sufficient to test dispersion of peaks in time.

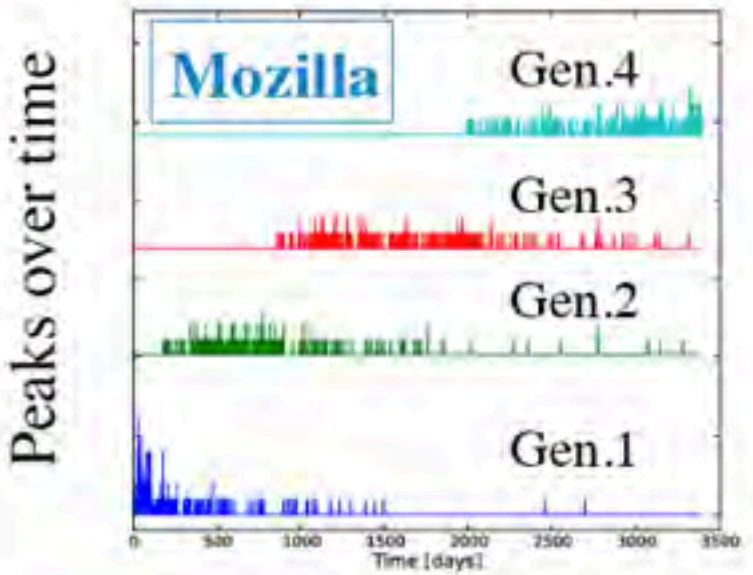


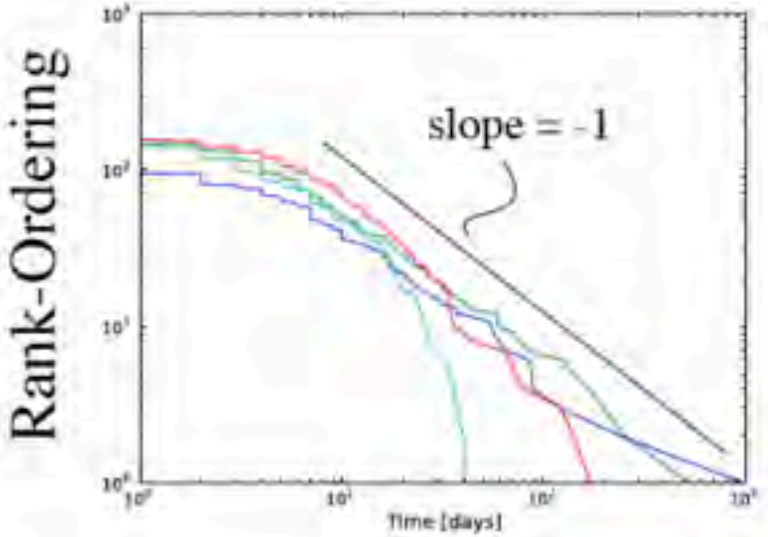
with Thomas MAILLART (ETH Zurich)

H1: Collective Action

- Heavy-tailed distribution of waiting times between peaks
  (for each generation)

- Consequences:
  - Scale-free structure of dynamics in work organisation
  - Clusters of activity peaks
  - Developers tend to work together (at the same time)

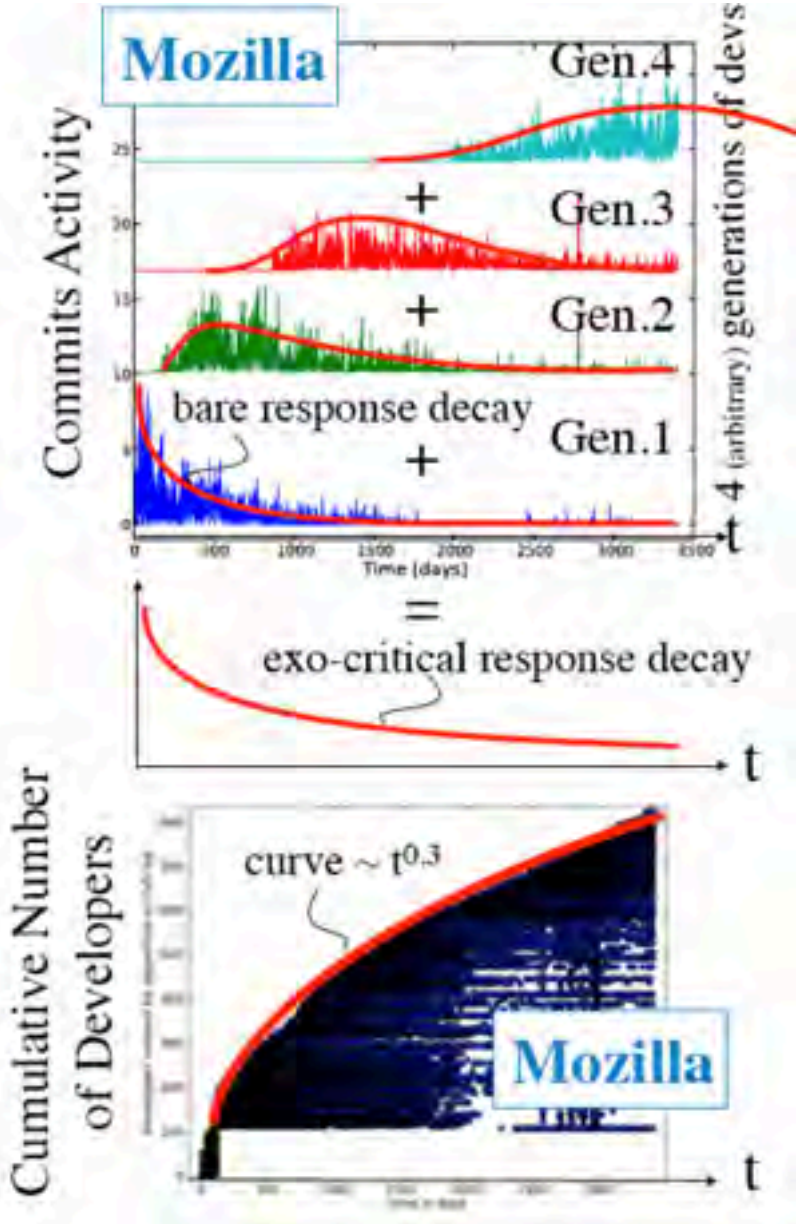




with Thomas MAILLART (ETH Zurich)

H2 : Critical Mass and Collective Action

- endos/exos theory predicts:
  - *k*-th generation is triggered by {1,..,*k*-1} generations
  - At each generation, dynamics (commits) become "smoother"
  - Population involved in the epidemic grows as $K(t) \sim t^{e}$, with $e \approx 0.3$



A. Saichev and D. Sornette, Hierarchy of Temporal Responses of Multivariate Self-Excited Epidemic Processes, Physical Review E (http://arxiv.org/abs/1101.1611)

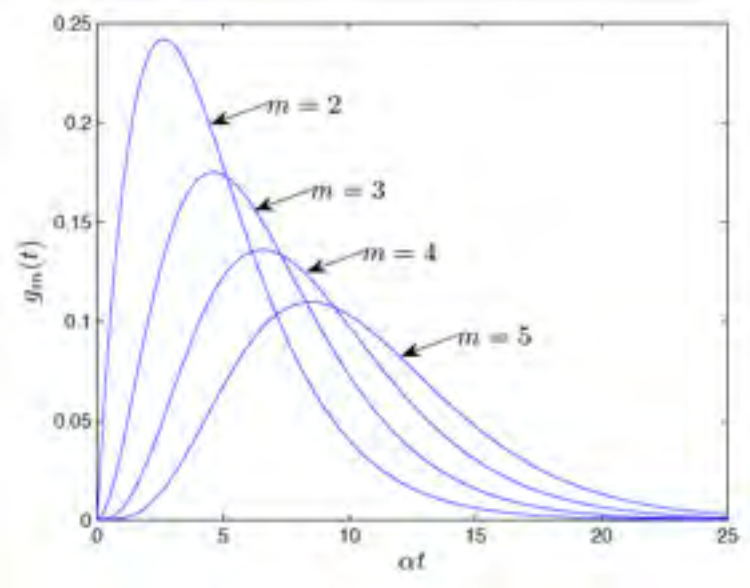
A. Saichev and D. Sornette, Generating Functions and Stability Study of Multivariate Self-Excited Epidemic Processes, Journal of Statistical Physics http://arxiv.org/abs/1101.5564

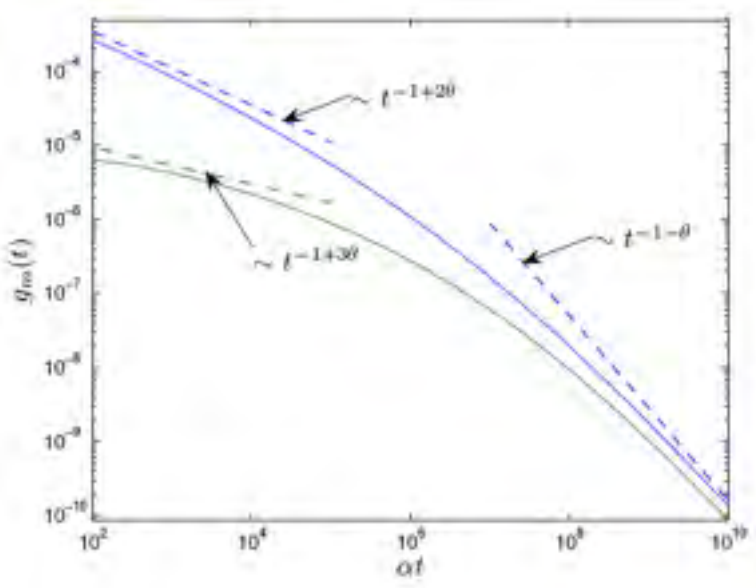
with Thomas MAILLART (ETH Zurich)

Hierarchy of Temporal Responses of Multivariate Self-Excited Epidemic Processes

$$\lambda_j(t|H_t) = \lambda_j^0(t) + \sum_{k=1}^{m} \Lambda_{kj} \int_{(-\infty,t)\times\mathcal{R}} f_{k,j}(t-s)\ g_k(x)\ N_k(ds \times dx)$$

ONE-DIMENSIONAL CHAIN OF DIRECTED TRIGGERING

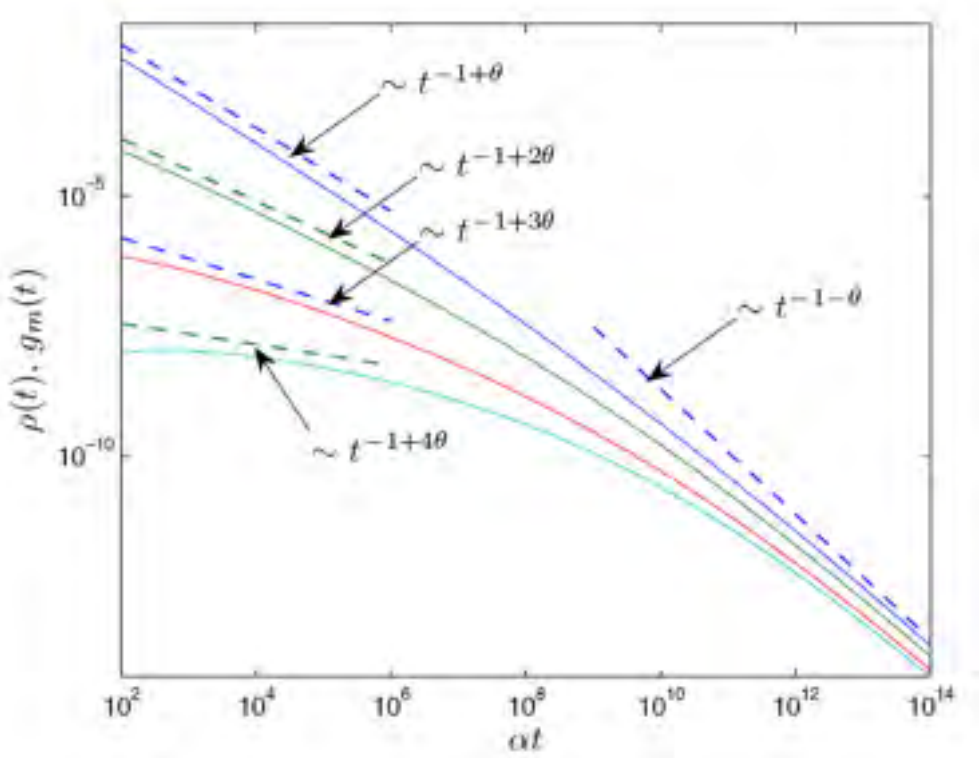


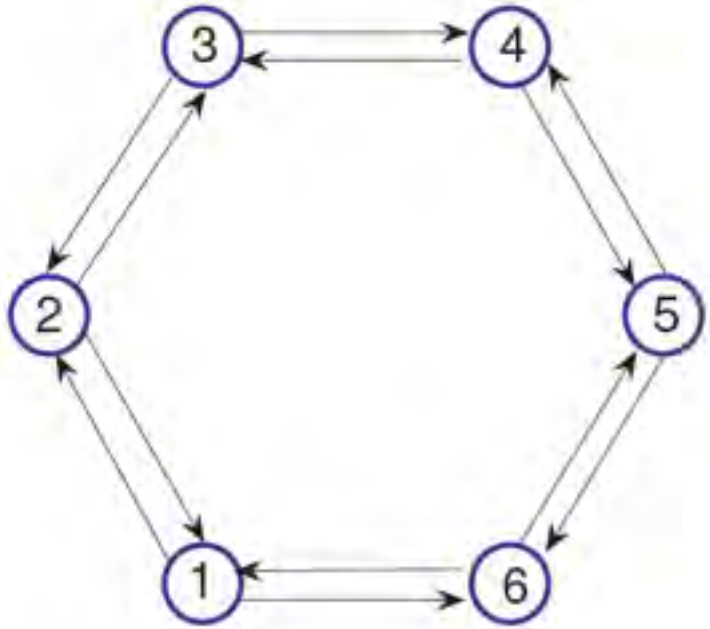


A. Saichev and D. Sornette, Hierarchy of Temporal Responses of Multivariate Self-Excited Epidemic Processes, Physical Review E (submitted 8 Jan. 2011) (http://arxiv.org/abs/1101.1611)

$$\lambda_j(t|H_t) = \lambda_j^0(t) + \sum_{k=1}^{m} \Lambda_{kj} \int_{(-\infty,t)\times\mathcal{R}} f_{k,j}(t-s)\ g_k(x)\ N_k(ds \times dx)$$

ONE-DIMENSIONAL CHAIN OF NEAREST-NEIGHBOR-TYPE TRIGGERING





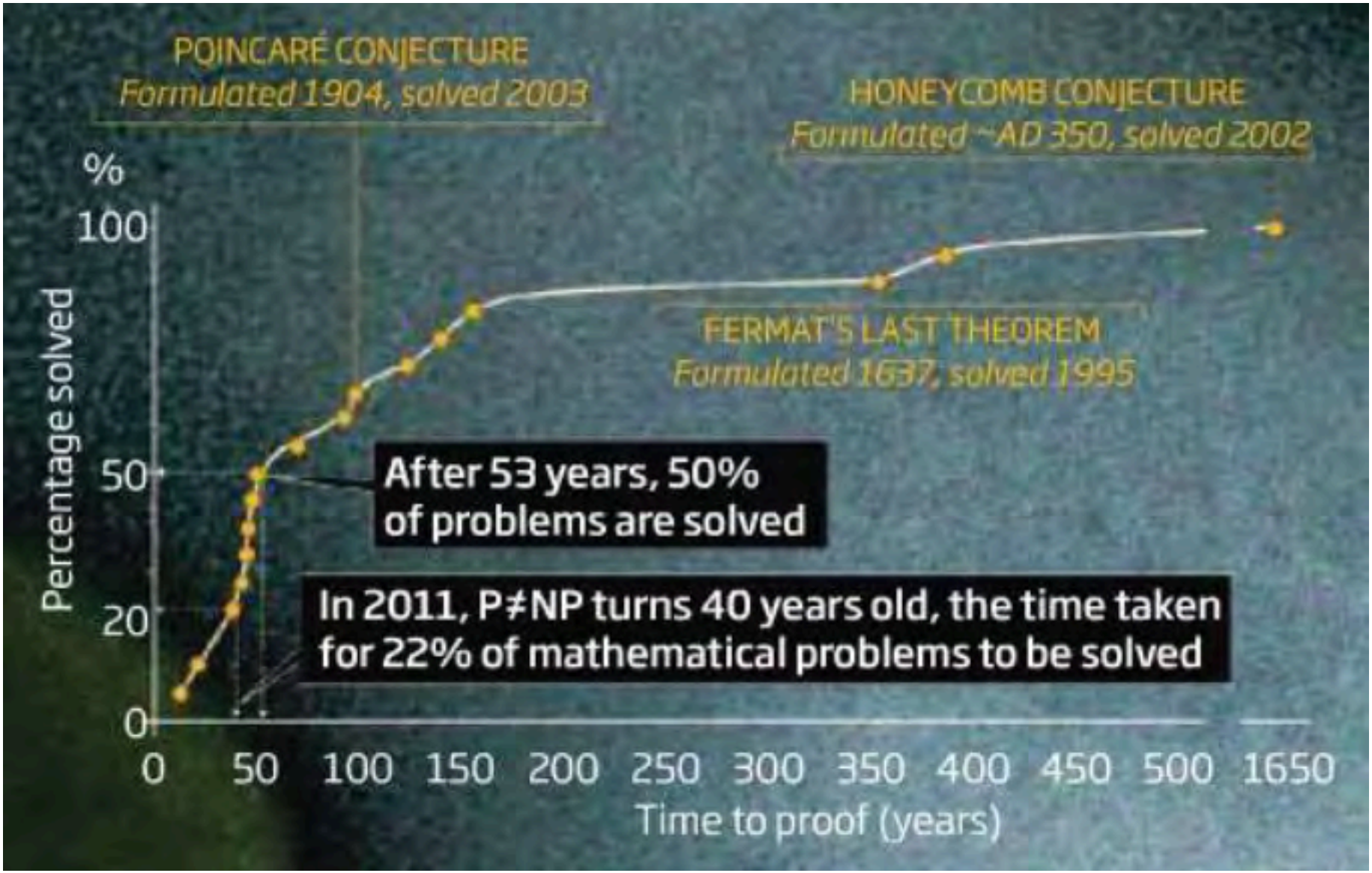
A. Saichev and D. Sornette, Hierarchy of Temporal Responses of Multivariate Self-Excited Epidemic Processes, Physical Review E (submitted 8 Jan. 2011) (http://arxiv.org/abs/1101.1611)

H0 + H1 + H2 = Colliding in OSS

- Endogenous critical structure of individual work
  - minimizes the energy spent for maximum output
  - epidemic like activity of developers
  - efficient transfer of knowledge from k^{th} to $(k+p)^{th}$ generation
- Open Source Projects
  - self-propelled by collective action triggering future action
  - joining rate (critical mass) is ensured by a successful epidemic
- Outlook
  - OSS can be compared a social epidemic in order to produce a good.
  - OSS viral organization and dynamics reflect some kind of optimal economic allocation of human ressources

Thomas Maillart | Chair of Entrepreunerial Risks | tmaillart@ethz.ch

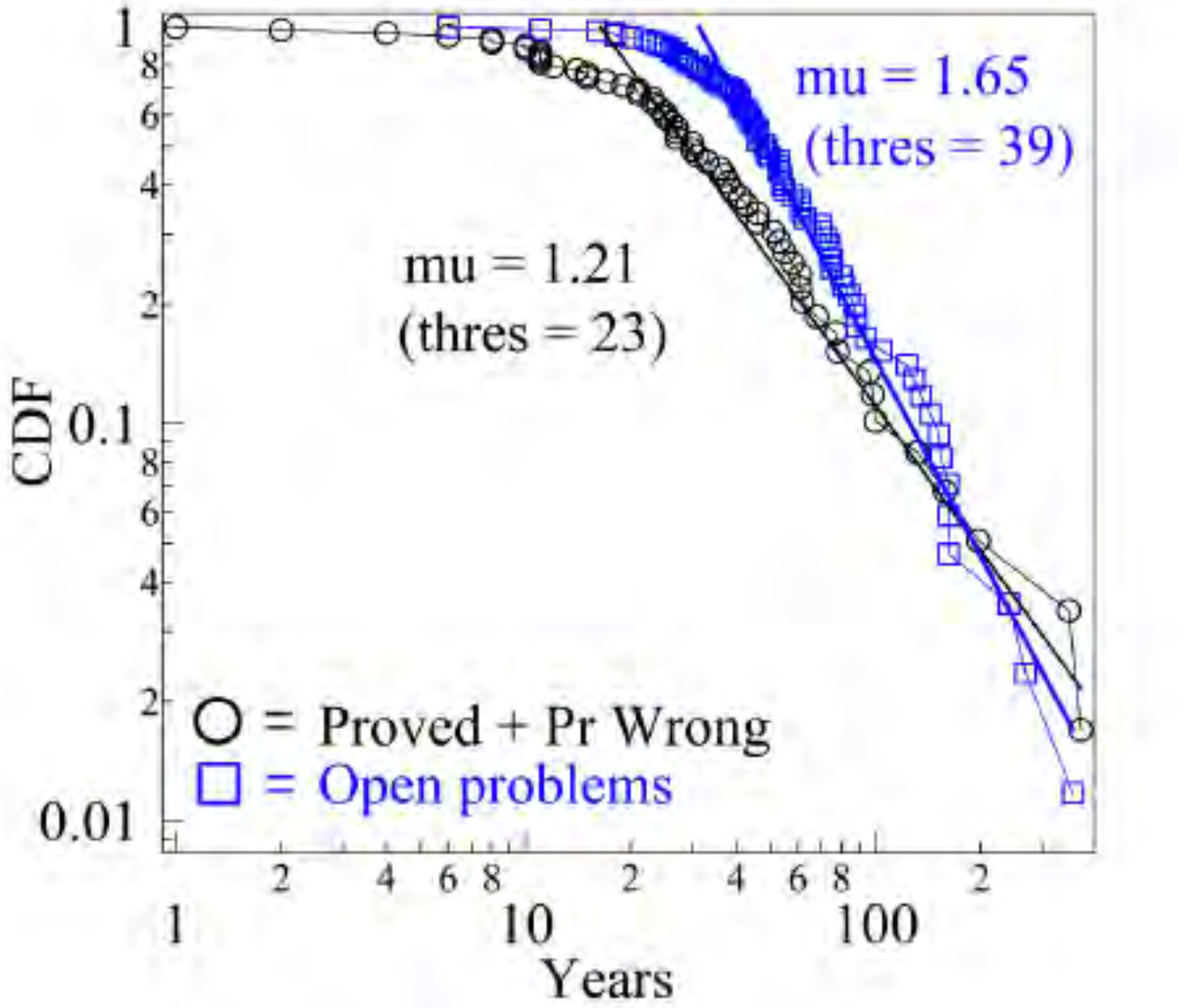
They used the time taken to solve 18 mathematical problems to estimate the probability that P versus NP is solved in 2011.



(Samuel Arbesman and Rachel Courland, Prediction: Proof unlikely, NewScientist, 25 December 2010/January 2011)

Problem Name	Raised By	Solved by	Year whe	Year whe	Years
Honey comb conjectu	Pappus	Hales	350	1998	1648
Kepler's conjecture	Kepler	Hales	1611	1998	387
Fermat's Last Theorer	Pierre de Fermat	Andrew Wiles	1637	1995	358
Catalan's conjecture	Eugène Charles Catal	Preda Mihăilescu.	1844	2002	158
???	???	???	???	???	140
Four Color Theorem	Francis Guthrie	Appel and Haken	1852	1976	124
Prime Number Theorm	Legendre	Hadamard and Poussin	1796	1896	100
Poincare conjecture	Henri Poincare	Grigori Perelman	1904	2002	98
???	???	???	???	???	90
Heawood Conjecture	Heawood	Ringel and Youngs	1890	1968	78
Bieberbach Conjecture	Bieberbach	Branges	1916	1984	68
Mordell conjecture	Mordell	Faltings	1922	1983	61
Oppenheim conjecture	Oppenheim	Margulis	1929	1987	58
Dodecahedral conjecti	Laszlo Fejes Toth	Hales and McLaughlin	1943	1998	55
Hirsch Conjecture	Hirsch and Dantzig	Leal	1957	2010	53
Burnside conjecture	William Burnside	Feit and Thomposn	1911	1962	51
Smith Conjecture	Paul A. Smith,	Meeks-Yau, et al	1930	1978	48
Kato's Conjecture	Kato	Auscher et al	1953	2001	48
Taniyama Shimura Cor	Taniyama	Breuli et al	1956	2001	45
Road Coloring Problem	Benjamin Weiss	Avraham Trahtman	1970	2009	39
Segal Conjecture	Grame Segal	Gunnar Carlsson	1969	2006	37
Langlands Correspond	Langland	Lafforgue	1967	1999	32
trong perfect graph co	Lovász	Chudnovsky, Robertsor	1972	2002	30
Scheinerman conjectu	Scheinerman	Chalopin and Goncalves	1984	2009	25
Star Height Problem	Eggan	Hashiguchi	1963	1988	25
Kruskal's tree theorem	Vázsonyi	Joseph Kruskal and S.	1937	1960	23
Serre's conjecture	Serre	Daniel Quillen and Andr	1955	1976	21
Cameron Erdos conje	Cameron and Erdos	Green and Sapozhenko	1988	2003	15
Dinitz conjecture	Jeff Dinitz	Fred Galvin	1979	1994	15
Gradient Conjecture	Thom	Kurdyaka, Mostowski ar	1989	2000	11

(with Ryohei Hisano, ETH Zurich)

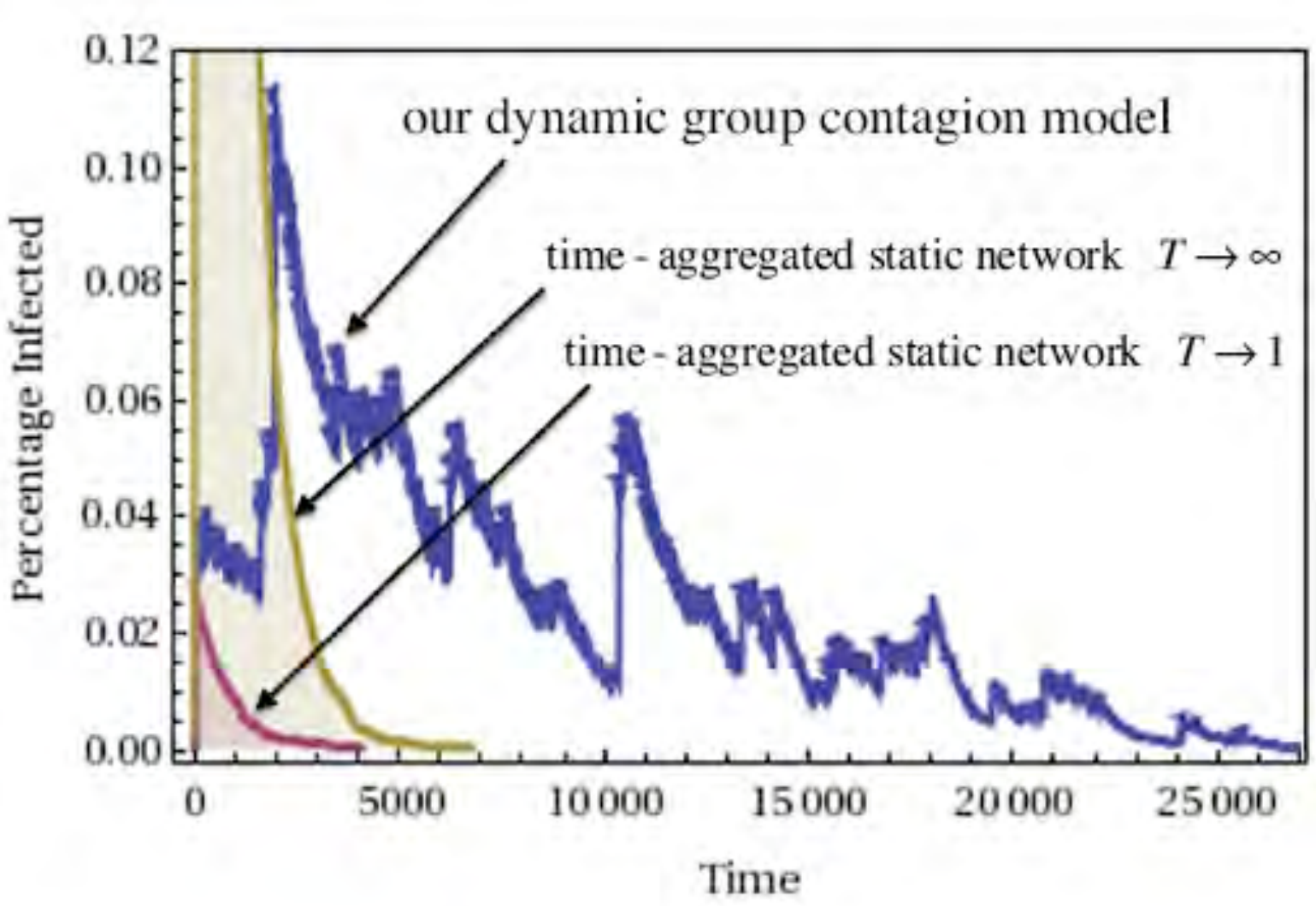


(with Ryohei Hisano, ETH Zurich)

Endogenous versus Exogenous

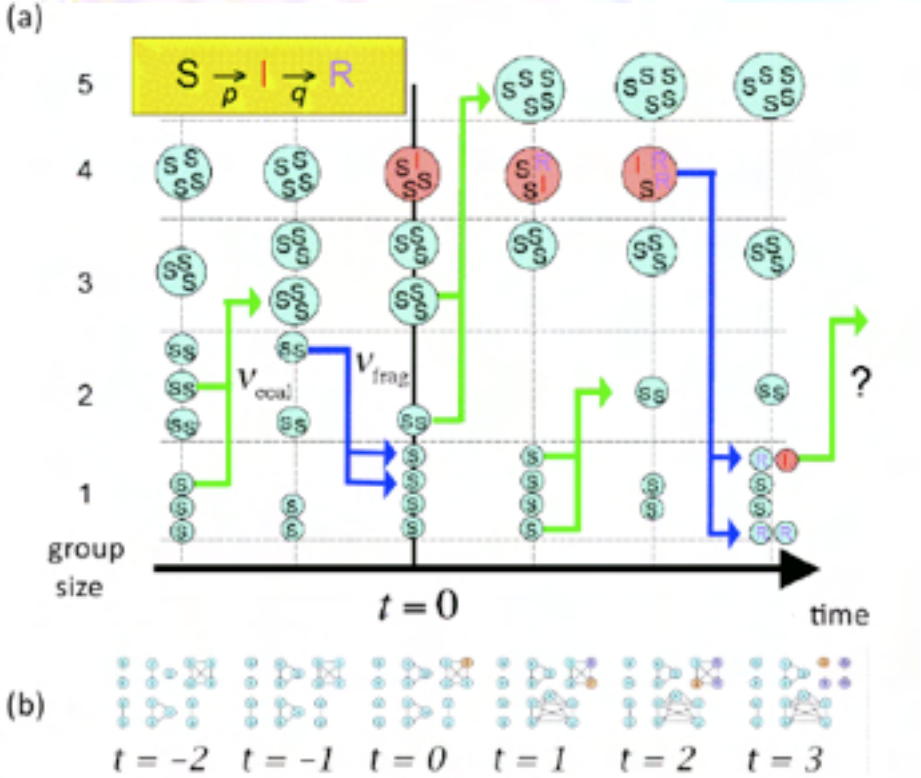
- In reality, varying mixture of endo and exo
- Adaptation of individuals to task flows
(θ may change and jump to new regimes)
- Adaptation of network to load and dynamic
(epidemic branching ratio may be time dependent and self-organized)
- Coagulation-fragmentation dynamics of networks on time scales comparable to epidemics dynamics

Common group dynamic drives real-world epidemics across social, financial and biological domains



Shenyuan Zhao, Juan Pablo Calderon, Chen Xu, Dan Fenn, Didier Sornette, Riley Crane, Pak Ming Hui and Neil F. Johnson, New dynamical network regime for modern epidemics, in press in Physical Review E (2010)

Common group dynamic drives real-world epidemics across social, financial and biological domains



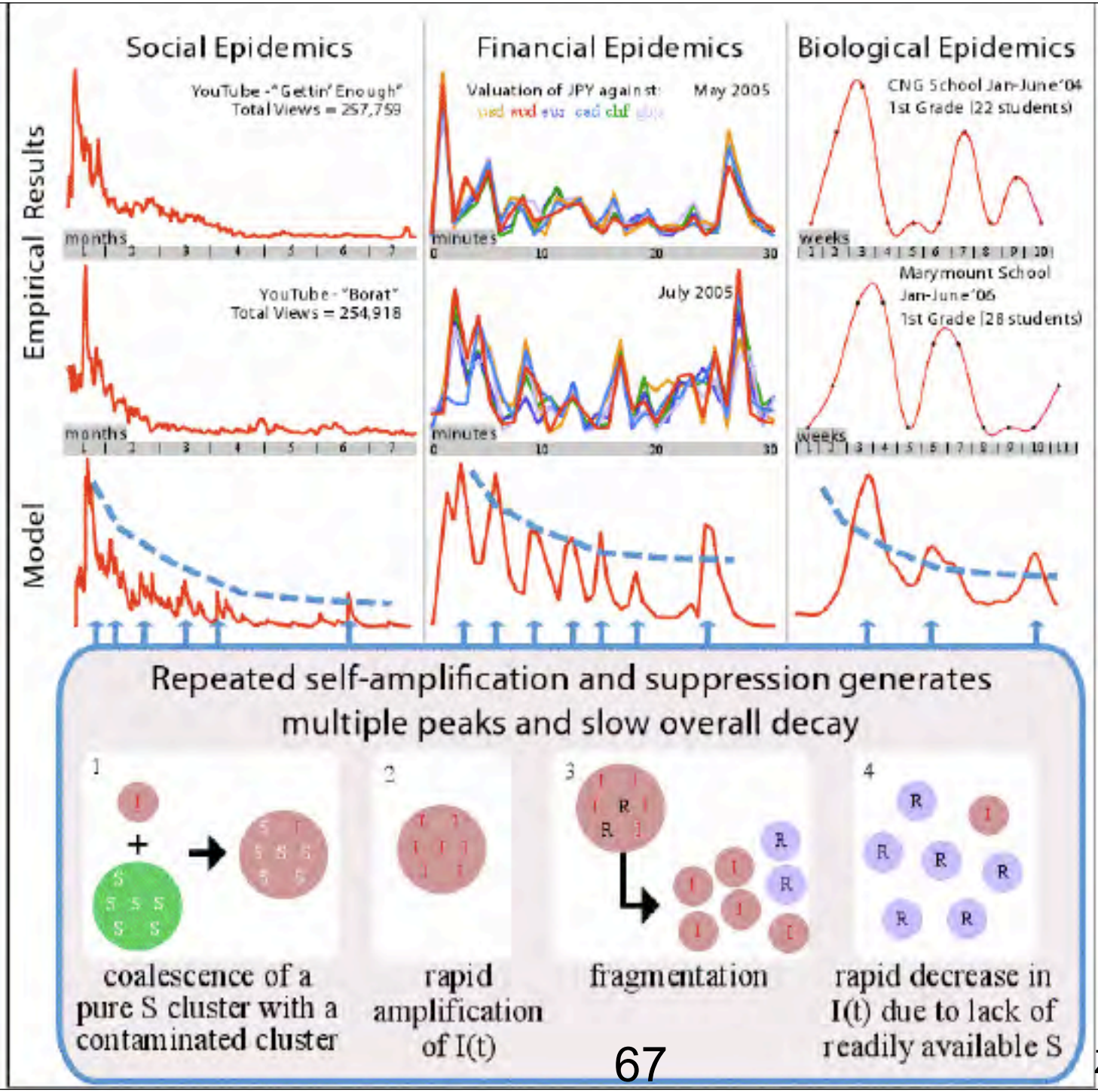
SIR equations

$$\frac{dS}{dt} = -pIS \quad \text{- f}$$

$$\frac{dI}{dt} = +pIS - qI \quad \text{+ f}$$

$$\frac{dR}{dt} = +qI$$

Zhao et al. (2010)

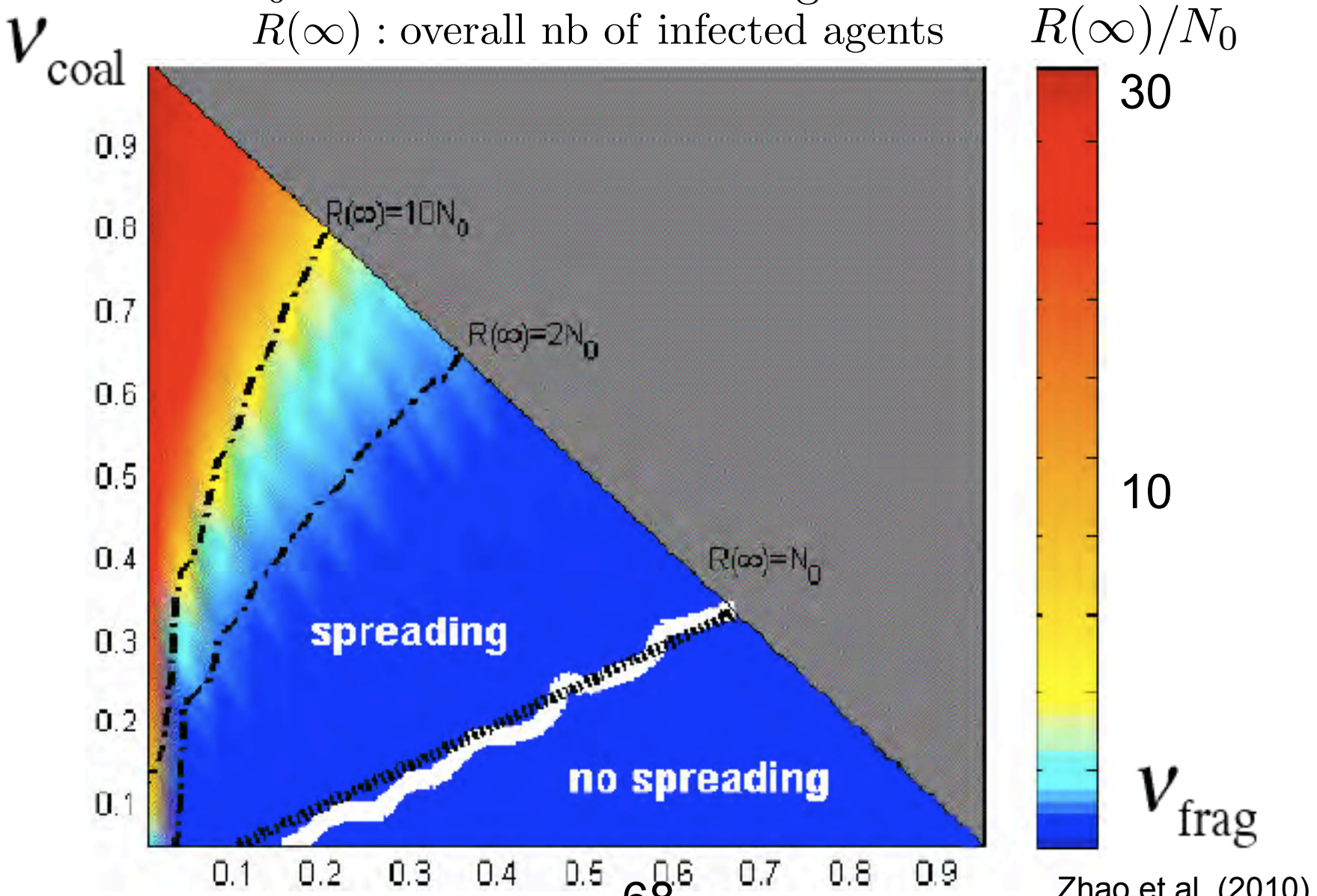


Zhao et al. (2010)

Application: Epidemic control strategy

N_0 : initial nb of infected agents

$R(\infty)$: overall nb of infected agents



Zhao et al. (2010)

Empirical Implications

I- ACTION METRICS: what is the efficiency of social compaigns? How to design them better?
How to manage in real time (or near-real time) and steer complex social systems, commercial sales, reputation branding, etc?

II- PREDICTING SUCCESS: forecast which product, action, innovation will be successful, where and how to allocate resources.

III-DYNAMICAL ENDO-EXO SEARCH: better search engine using the time dynamics of the endo-exo approach.

Endogenous versus Exogenous

Extinctions

- -meteorite at the Cretaceous/Tertiary KT boundary
- -volcanic eruptions (Deccan traps)
- -self-organized critical events

Discoveries

- -serendipity
- -maturation

Financial crashes

- -external shock
- -self-organized instability

Volatility bursts in financial time series

- -external shock
- -cumulative effect of "small" news

Earthquakes

- -tectonic driving
- -triggering

Immune system

- -external viral or bacterial attack
- - " internal" (dis-)organization

Parturition

- -mother/foetus triggered?
- -mother-foetus complex?

Brain (learning)

- -external inputs
- -internal self-organization and reinforcements (role of sleep)

Aviation industry recession

- -September 11, 2001
- -structural endogenous problems

Commercial success and sales

- -Ads
- -epidemic network

Recovery after wars

- -internally generated (civil wars)
- -externally generated

Social unrests

- -triggering factors
- -rotting of social tissue