Emerging generalized Fermi-Dirac distribution in Lévy branching and annihilating process

Marcelo Lyra

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Statistical Mechanics for Complexity (Tsallis 80th)

Rio de Janeiro, Brazil , November 06-10, 2023

Constantino Tsallis and UFAL

- First visit in 1976
- 1980s: Constantino supported the emerging statistical mechanics group at UFAL. Scientific collaborations with Enaldo Sarmento, Roberto Jorge, Solange Bessa, Uriel Costa
- 1984: I presented to Constantino my undergraduate research Project
- 1997: During Constantino visit to UFAL, we developed the work relating the q-Tsallis parameter to scaling exponents of multifractal attractors
- 27 articles in collaboration with colleagues from UFAL

Solid State Communications, Vol.44,No.6, pp.777-780, 1982.
Printed in Great Britain.

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Pergamon Press Ltd.

FERROMAGNETIC PHASE BREAKDOWN OF A QUENCHED BOND-MIXED ISING MODEL*

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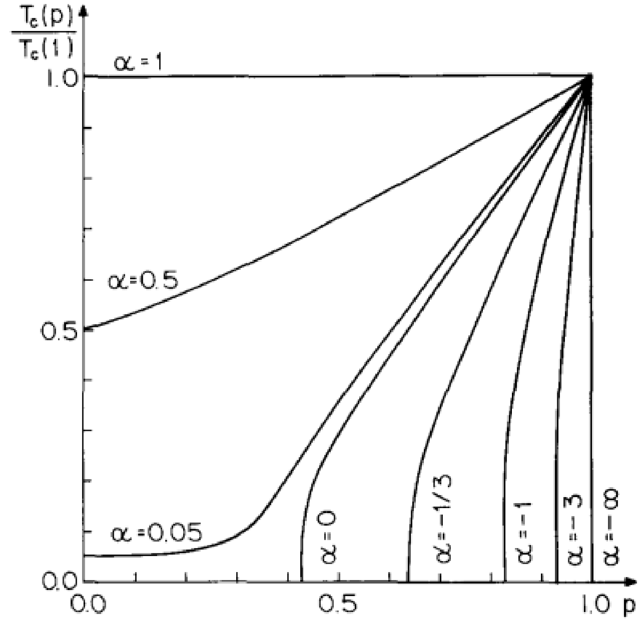

FIG. 1 The critical temperature (corresponding to the ferromagnetic stability limit) as a function of J_2-bond concentration for typical values of $\alpha \equiv J_1/J_2$.

J. Phys. A: Math. Gen. **16** (1983) 3601–3610. Printed in Great Britain

On the critical point of the fully anisotropic quenched bond-random Potts ferromagnet in triangular and honeycomb lattices

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$$[1/T_c(1)][\mathrm{d}T_c(p)/\mathrm{d}p]|_{p=1} = \begin{cases} 1.7770\ldots & (1.7770\ldots; \quad 0\% \text{ error}) & \text{for } q=1 \\ 1.5998\ldots & (1.5782\ldots; \quad 1.37\% \text{ error}) & \text{for } q=2 \\ 1.5142\ldots & (1.4659\ldots; \quad 3.30\% \text{ error}) & \text{for } q=3 \\ 1.4609\ldots & (1.3863\ldots; \quad 5.39\% \text{ error}) & \text{for } q=4 \end{cases}$$

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North-Holland

PHYSICA A

Temperature-dependent “frustration”: a thermodynamic rather than a topological effect

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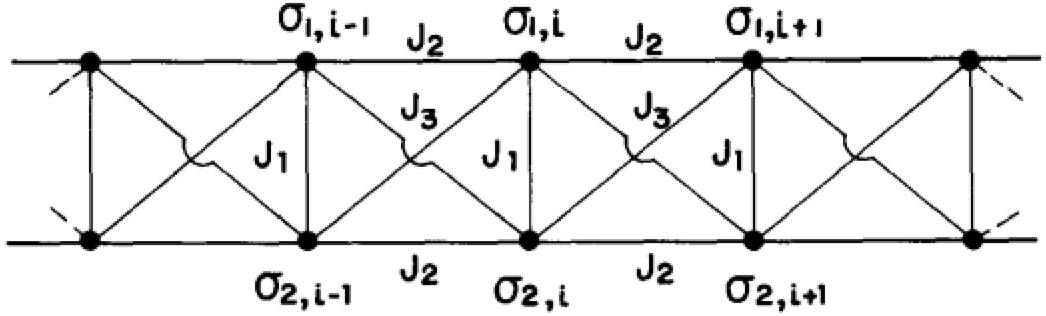
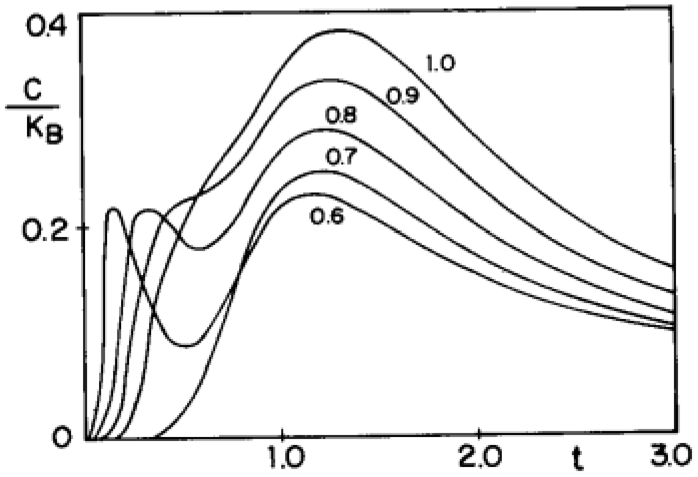


Fig. 1. 2N linear strip of Ising spins. J_1 and J_2 are nearest-neighbor interactions. J_3 is a next-nearest neighbor interaction.



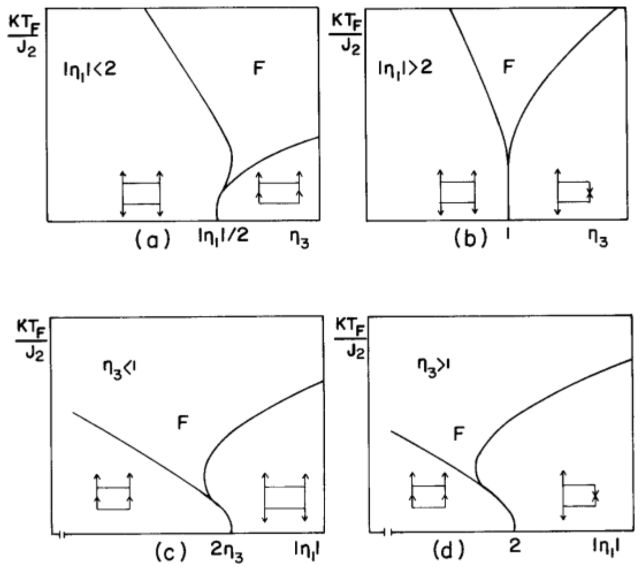


Fig. 5. Frustration temperature as a function of the parameters η_1 and η_3. (a) $\eta_1 = -1.4$, (b) $\eta_1 = -2.4$, (c) $\eta_3 = 0.8$, (d) $\eta_3 = 1.2$. The graphics show specific values of η_1 and η_3 but the qualitative behavior is the same in the indicated intervals.

Tome 46 Nº 18 15 SEPTEMBRE 1985

LE JOURNAL DE PHYSIQUE - LETTRES

J. Physique Lett. **46** (1985) L-851 - L-859 15 SEPTEMBRE **1985,** PAGE L-851

Classification
Physics Abstracts
05.50 — 05.70F — 75.10J — 82.65D

Anisotropic Heisenberg surface on semi-infinite Ising ferromagnet : renormalization group treatment

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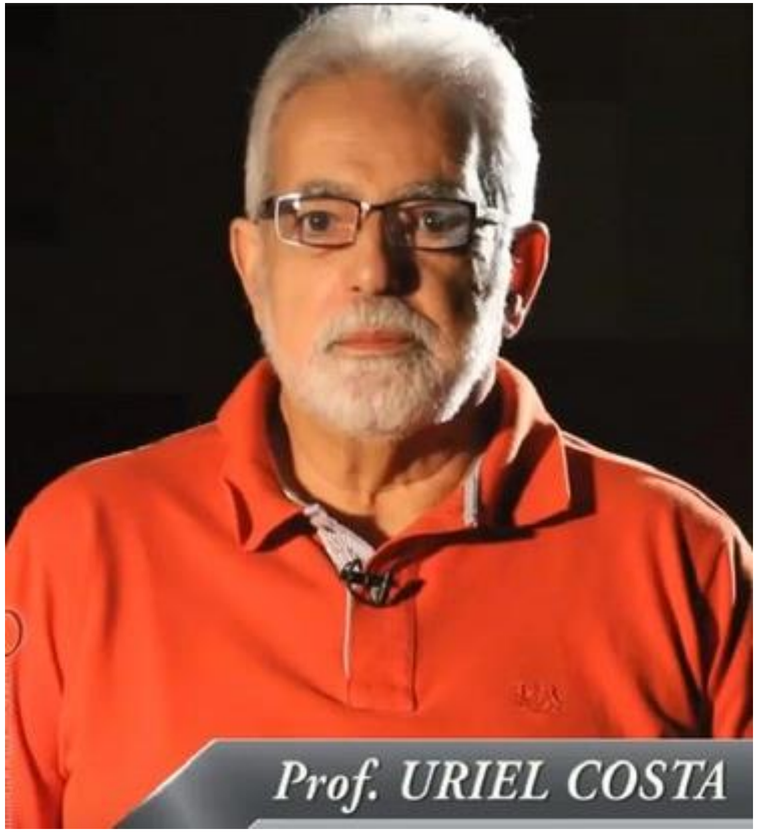

The bond-diluted interface between semi-infinite Potts bulks: criticality

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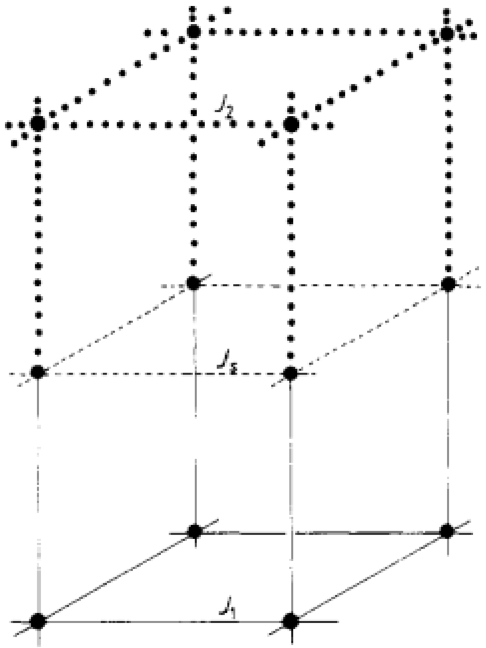

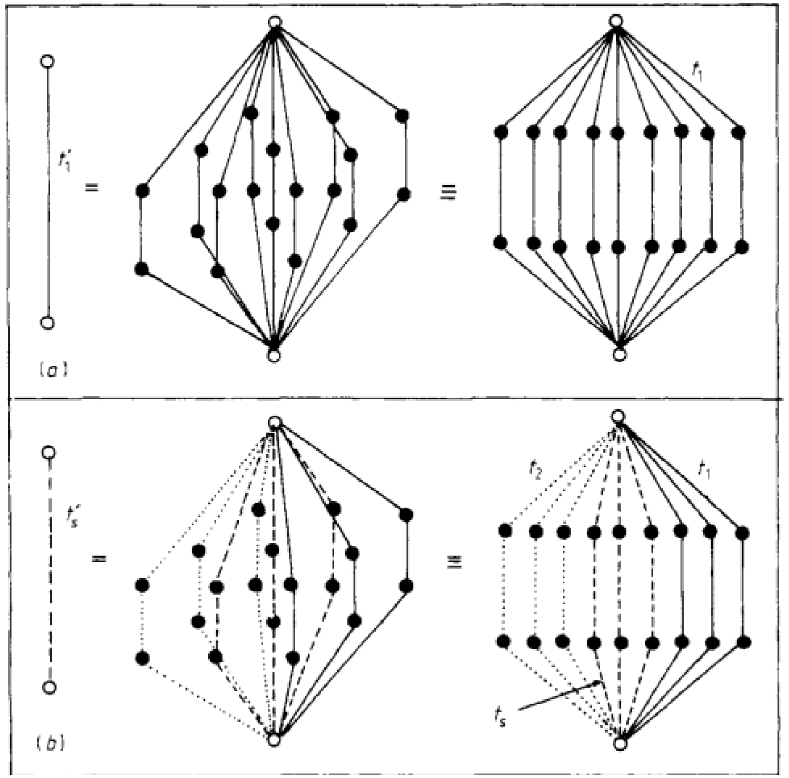

PHYSICAL REVIEW E VOLUME 56, NUMBER 1 JULY 1997

Power-law sensitivity to initial conditions within a logisticlike family of maps: Fractality and nonextensivity

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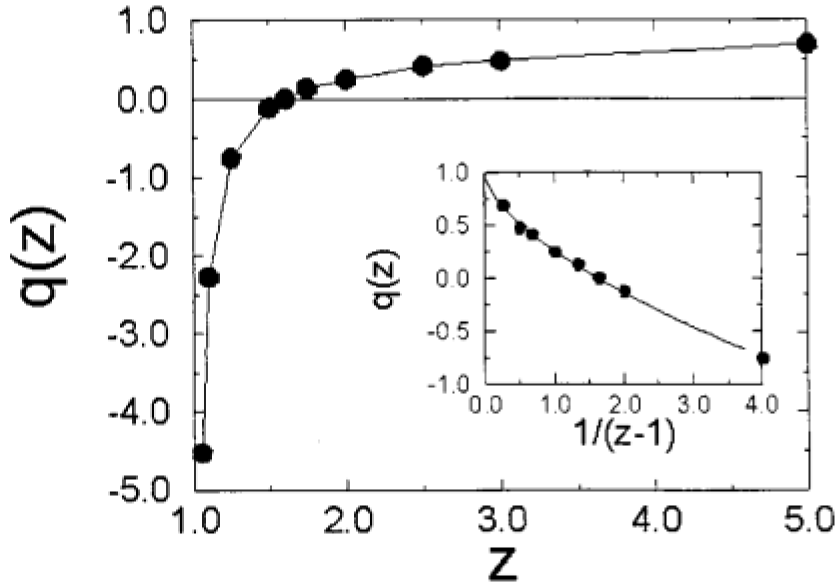
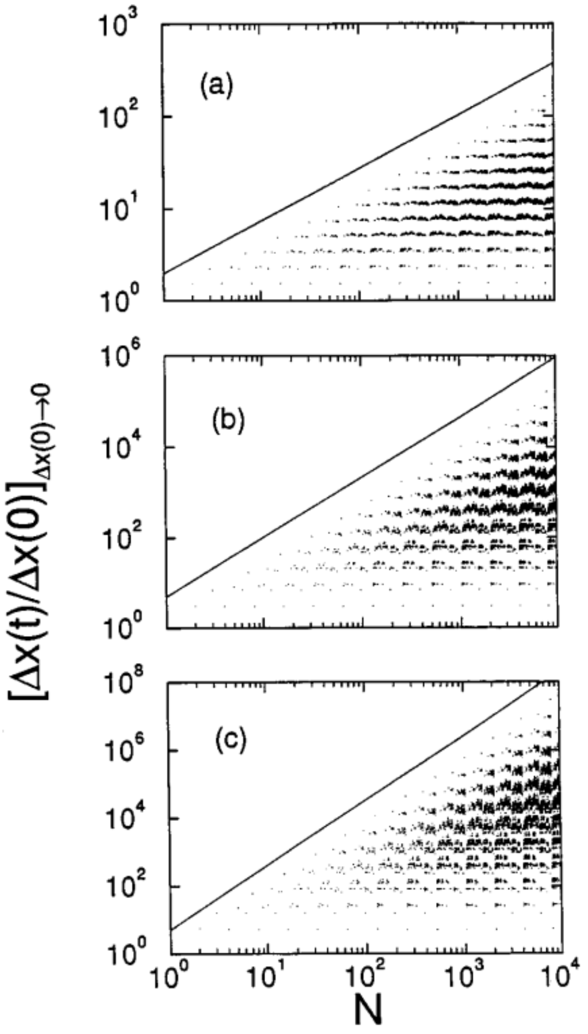
(Received 6 January 1997)

$$x_{t+1} = 1 - a|x_t|^z$$

$$\lim_{\Delta x(0)\to 0} \frac{\Delta x(t)}{\Delta x(0)} = [1 + (1-q)\lambda_q t]^{1/(1-q)}$$





Nonextensivity and Multifractality in Low-Dimensional Dissipative Systems

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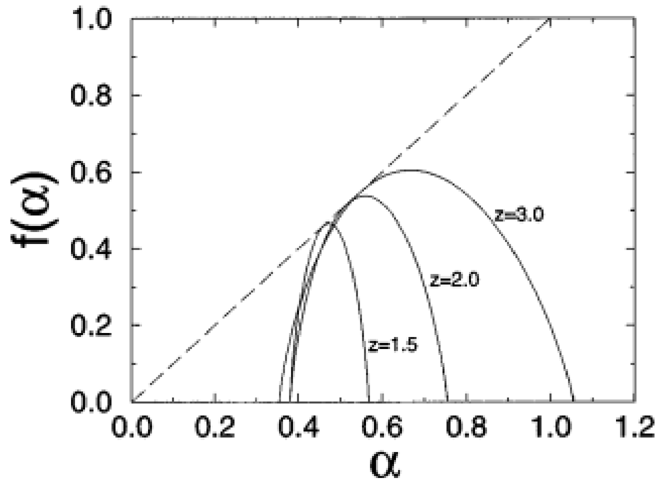


FIG. 1. Multifractal singularity spectra of the critical attractor of generalized logistic maps with $z = 1.5$, 2.0, and 3.0 as numerically obtained following the prescription in Ref. [14].

$$\frac{1}{1-q} = \frac{1}{\alpha_{\min}} - \frac{1}{\alpha_{\max}} . \qquad (7)$$

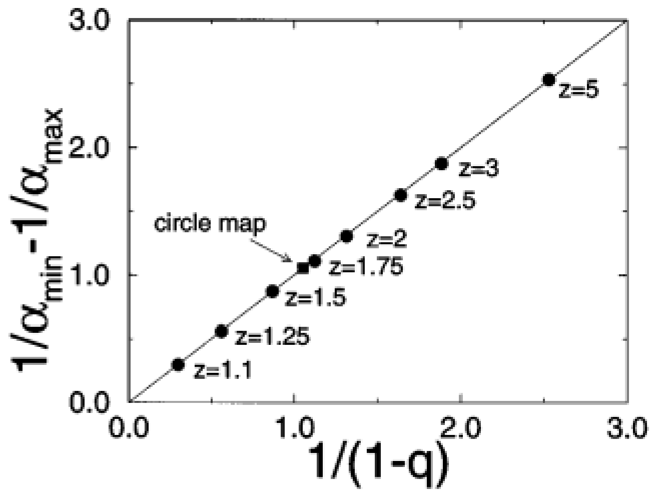
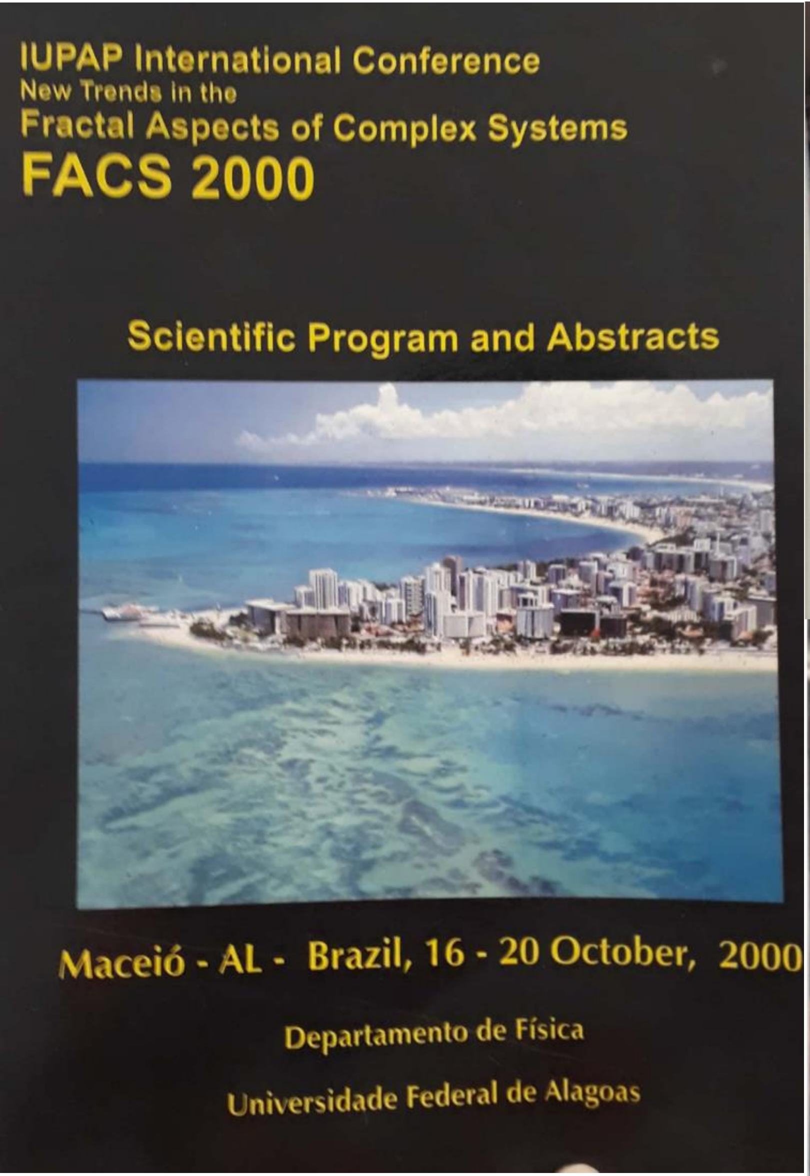


FIG. 4. $1/\alpha_{\min} - 1/\alpha_{\max}$ versus $1/(1-q)$ for the generalized logistic map (circles) and for the circle map (square). The straight line represents the scaling prediction.


IUPAP International Conference
New Trends in the
Fractal Aspects of Complex Systems
FACS 2000
Scientific Program and Abstracts
Maceió - AL - Brazil, 16 - 20 October, 2000
Departamento de Física
Universidade Federal de Alagoas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PHYSICA A

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Short-time dynamics of isotropic and anisotropic Bak–Sneppen model: extensive simulation results

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Proceedings of the International Workshop on 'Trends and perspectives in extensive and non-extensive statistical mechanics', in honor of the 60th birthday of Constantino Tsallis

19-21 November 2003 • Angra dos Reis, Brazil

PHYSICAL REVIEW E **101**, 052136 (2020)

Emerging extreme value and Fermi-Dirac distributions in the Lévy branching and annihilating process

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II. THE PURE LEVY BRANCHING AND ANNIHILATION PROCESS

Here, we consider the branching and annihilating of *static* particles A that generate a single offspring $A \to 2A$ to the left or to the right with equal probability. The particles annihilate upon contact $A + A \to \oslash$, i.e., when the branching process tries to generate an offspring in an already occupied site. These processes can be represented by the reaction equations

$$A \longrightarrow (nA + A), \tag{1}$$

$$A + A \longrightarrow \oslash. \tag{2}$$

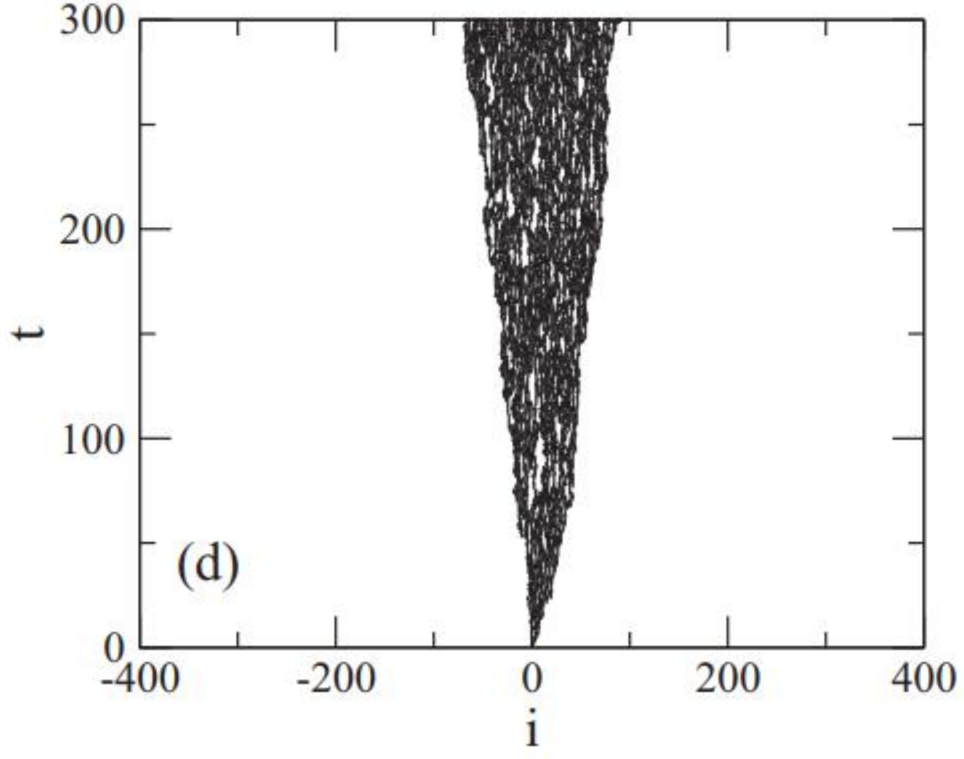
Here, $n = 1$ is the number of offspring. The branching distance r is assumed to follow a Lévy power-law distribution. This is effectively accounted by choosing the branching distance as

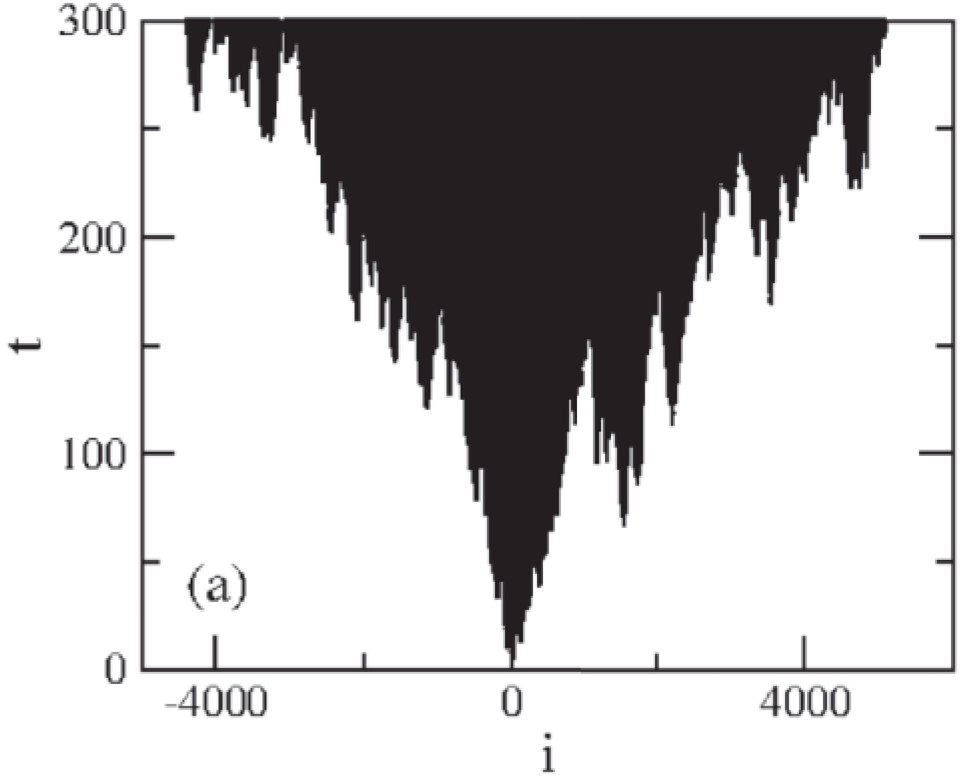
$$r = (1 - x)^{-1/(\alpha-1)}. \tag{3}$$

Here, x is a uniformly distributed random number in the interval $0 \leqslant x < 1$. Only the integer part of r is considered. It follows a Lévy power-law distribution in the form

$$P(r) \propto \frac{1}{r^{\alpha}} \tag{4}$$

Space-time growth process





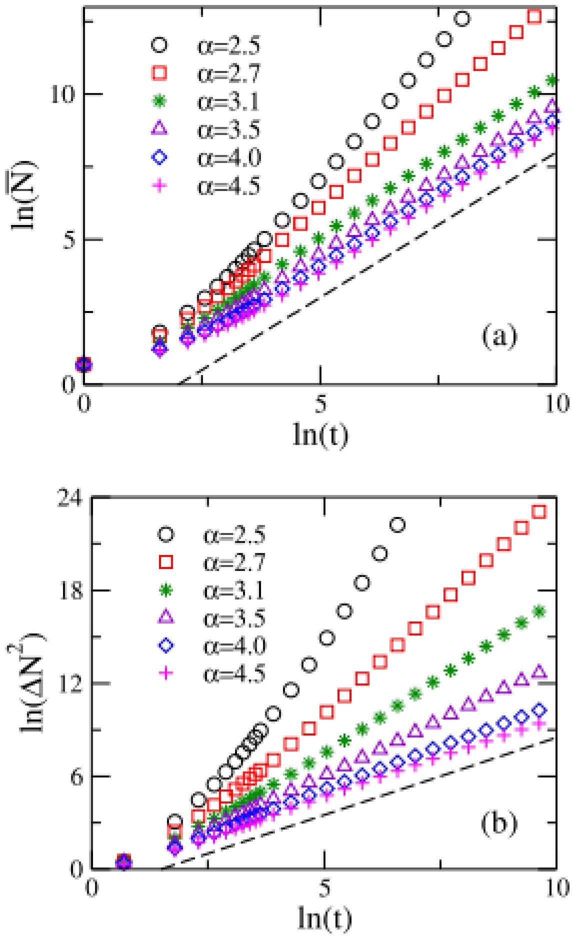


FIG. 2. In (a) we present the time evolution of the mean number of particles, and in (b) its quadratic fluctuations for distinct values of α. The long-time slopes give the respective dynamic exponents. Notice that, while the dynamic exponent of $\overline{N}(t)$ starts to change for $\alpha < 3$, its fluctuation exponent already deviates from the short-range behavior for $\alpha < 4$. Dashed lines have unitary slope corresponding to the expected short-range behavior.

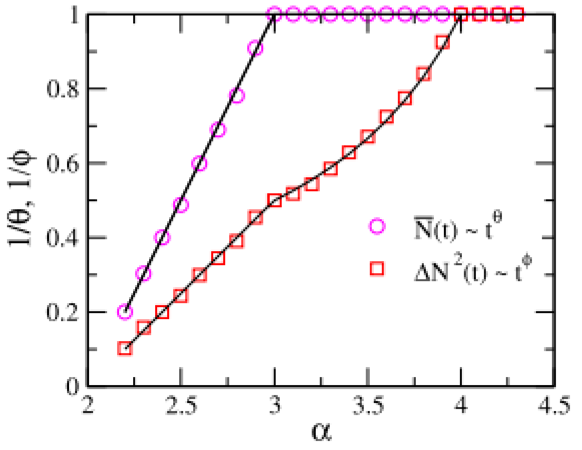


FIG. 3. Dynamic exponents associated with the average particle number θ and its quadratic fluctuations ϕ for distinct values of α. For $\alpha \geqslant 4$ the short-range values set up $\theta = \phi = 1$. For $2 < \alpha \leqslant 3$ one finds $\phi = 2\theta = 2/(\alpha - 2)$. For $3 \leqslant \alpha \leqslant 4$ one identifies an intermediate regime with $\theta = 1$ and $\phi = 5 - \alpha$.

Generalized Fermi-Dirac occupation profile

$$\overline{n}(x) = \frac{n_0}{\{\exp_q[-\beta(x - x^*)]\}^{-1} + 1},$$

where

$$\exp_q(x) = [1 + (1 - q)x]^{1/(1-q)},$$

q=1 for short-ranging branchings

q> 1 for long-range branchings (q=1.46 forα=2.3)

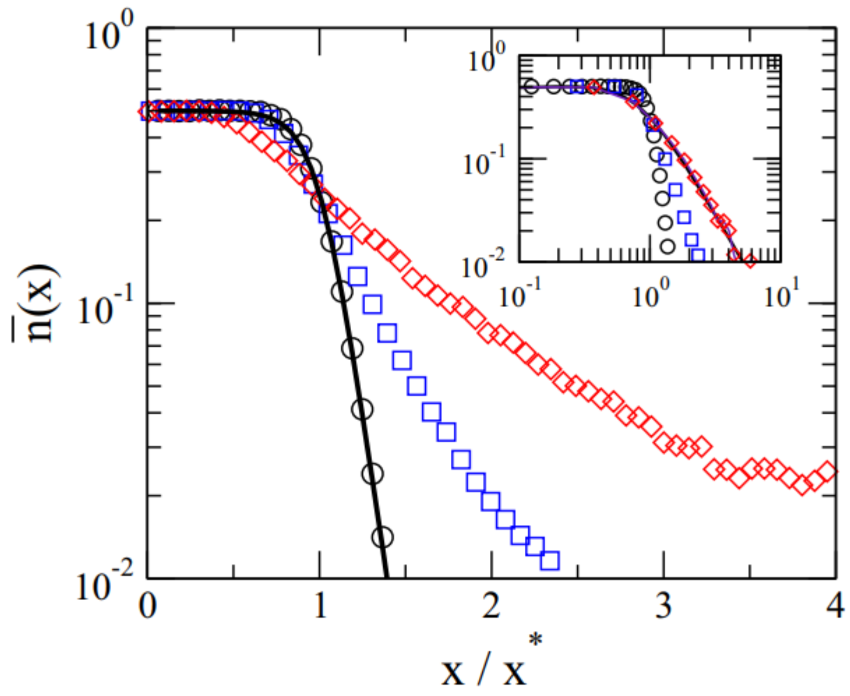
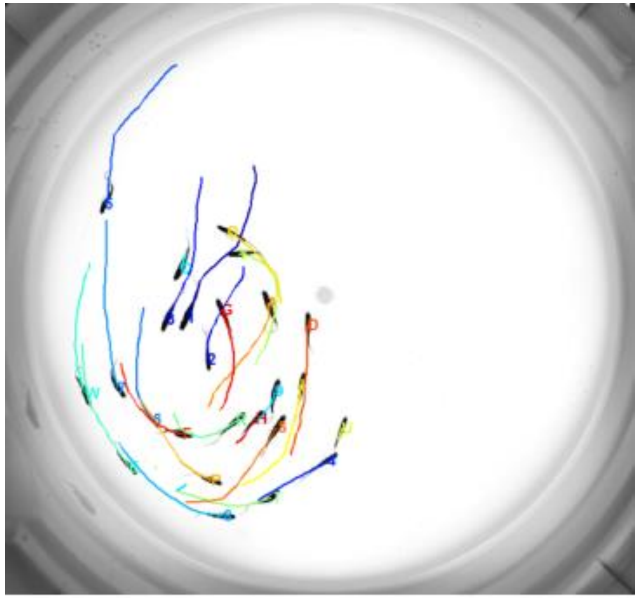
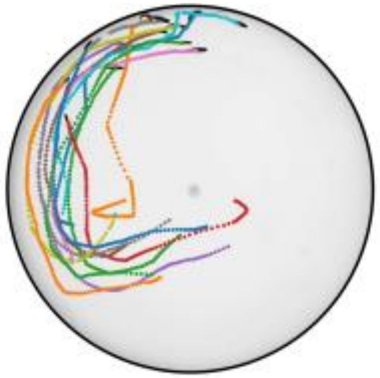
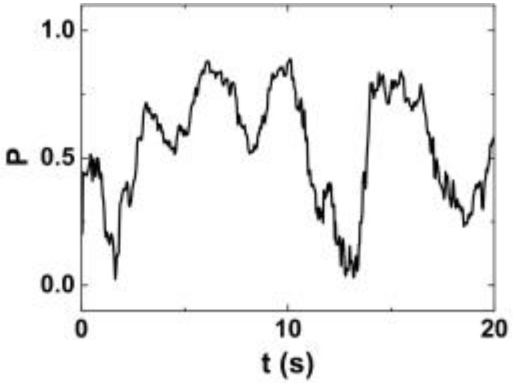


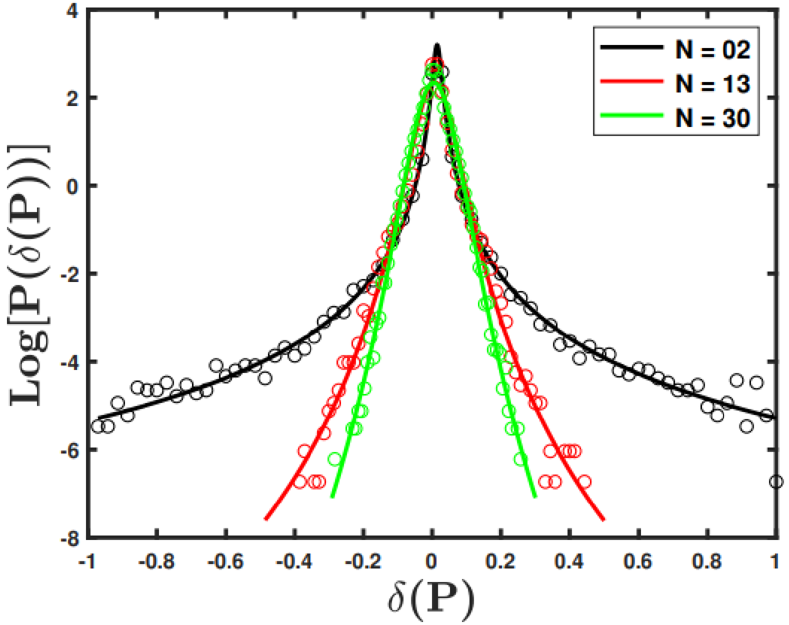
FIG. 7. Average occupation number distribution $\overline{n}(x)$ as a function of the normalized distance to the seed position x/x^*, where $\overline{n}(x^*) = n_0/2$. Data are for $\alpha = 4$ (circles), $\alpha = 3$ (squares), and $\alpha = 2.3$ (diamonds). Solid line is a fit to the Fermi-Dirac distribution given in Eq. (11). Inset: Double logarithmic plot of the same data. Solid line is a fit to the Fermi-Dirac distribution in the context of nonextensive statistics given in Eq. (12). Data were taken at $t = 100$ from 10^4 distinct realizations.

For the 90th Birthday
q-Distributions in Zebrafish collective swimming









N	q	R^2
2	$2,03 \pm 0,09$	0,98
13	$1,38 \pm 0,08$	0,98
30	$1,24 \pm 0,04$	0,99

Final remarks

- Thanks Constantino for your invaluable contribution to the Physics Institute of UFAL.
- We celebrate the influence and inspiration you've in our lives.
- May we all have a wonderful week;
- Happy 80ths (the new 60ths)
- In q-World, relaxation towards equilibruim is slower