Characterizing Spatiotemporal Complex Patterns with GPA & Tsallis Permutation Entropy

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Timeline

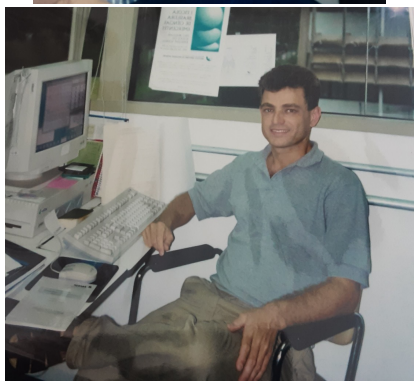
1998

FAPESP CNPq CAPES

1.ª Escola Brasileira de Ciências Emergentes | São José dos Campos - SP

Processo: 98/11624-3
Linha de fomento: Auxílio Organização - Reunião Científica
Vigência: 22 de novembro de 1998 - 26 de novembro de 1998
Área do conhecimento: Ciências Exatas e da Terra - Física - Áreas Clássicas de Fenomenologia e suas Aplicações

Pesquisador responsável: Reinaldo Roberto Rosa
Beneficiário: Reinaldo Roberto Rosa




1998


1998


Study & Adventure
AUSTRALIA
NOVA ZELANDIA
SUIPA
AUSTRALIA
NOVA ZELANDIA
SUIPA
AUSTRALIA
NOVA ZELANDIA
SUIPA

1998

21st IUPAP International Conference on Statistical Physics (STATPHYS 21)

15-21 July 2001. Cancun, Mexico (C01-07-15.1)

ELSEVIER

Nonlinear Analysis: Theory, Methods & Applications

Volume 47, Issue 5, August 2001, Pages 3521-3530

Nonextensive thermostatistics description of intermittency in turbulence and financial markets

Fernando M. Ramos, Reinaldo R. Rosa, Camilo Rodrigues Neto, Mauricio J.A. Bolzan, Leonardo D. Abren Sá

ELSEVIER

Physica A: Statistical Mechanics and its Applications

Volume 344, Issues 3–4, 15 December 2004, Pages 554-561

Value-at-risk and Tsallis statistics: risk analysis of the aerospace sector

Adriana P. Mattedi [a], Fernando M. Ramos [a], Reinaldo R. Rosa [a], Rosario N. Mantegna [b]

Tsallis

Harry L. Swinney | University of Texas at Austin - Estados Unidos

Processo: 01/03488-7
Linha de fomento: Auxílio à Pesquisa - Pesquisador Visitante - Internacional
Vigência: 31 de maio de 2001 - 17 de junho de 2001
Área do conhecimento: Ciências Exatas e da Terra - Física - Áreas Clássicas de Fenomenologia e suas Aplicações
Pesquisador responsável: Reinaldo Roberto Rosa
Beneficiário: Reinaldo Roberto Rosa
Pesquisador visitante: Harry L. Swinney
Inst. do pesquisador visitante: University of Texas at Austin (UT) (Estados Unidos)

CBPF

ELSEVIER

Physica A: Statistical Mechanics and its Applications

Volume 295, Issues 1–2, 1 June 2001, Pages 250-253

Non-extensive statistics and three-dimensional fully developed turbulence

Fernando M. Ramos [a], Reinaldo R. Rosa [a], Camilo Rodrigues Neto [a], Mauricio J.A. Bolzan [a], Leonardo D.Abreu Sá [a], Haroldo F. Campos Velho [a]

Honorable Mention
for the pioneering work
Applying Tsallis's Statistics
in Turbulence

Los Alamos
NATIONAL LABORATORY
EST.1943

ELSEVIER

Computer Physics Communications

Volume 147, Issues 1–2, 1 August 2002, Pages 556-558

Generalized thermostatistics description of probability densities of turbulent temperature fluctuations

Fernando M. Ramos [a], Reinaldo R. Rosa [a], Camilo Rodrigues Neto [a], Mauricio J.A. Bolzan [b], Leonardo D.Abreu Sá [b]

Go to Physica D: Nonlinear Phenomena on ScienceDirect

ELSEVIER

Physica D: Nonlinear Phenomena

Volume 193, Issues 1–4, 15 June 2004, Pages 1-2

Preface

Anomalous Distributions, Nonlinear Dynamics, and Nonextensivity

Harry Swinney [a], Constantino Tsallis [b 1]

[a] Department of Physics, Center for Nonlinear Dynamics, University of Texas at Austin, Austin, TX 78712, USA
[b] CBPF, Brazilian Center for Research in Physics, The Rio de Janeiro 22290-180, RJ, Brazil

JOURNAL OF GEOPHYSICAL RESEARCH
Atmospheres
AN AGU JOURNAL

Climate and Dynamics | Free Access

Analysis of fine-scale canopy turbulence within and above an Amazon forest using Tsallis' generalized thermostatistics

Maurício J. A. Bolzan, Fernando M. Ramos, Leonardo D. A. Sá, Camilo Rodrigues Neto, Reinaldo R. Rosa

First published: 06 September 2002 | https://doi.org/10.1029/2001JD000378 | Citations: 24

ELSEVIER

Physica D: Nonlinear Phenomena

Volume 193, Issues 1–4, 15 June 2004, Pages 278-291

Atmospheric turbulence within and above an Amazon forest

Fernando Manuel Ramos [a], Maurício José Alves Bolzan [b], Leonardo Deane Abreu Sá [a c], Reinaldo Roberto Rosa [a]

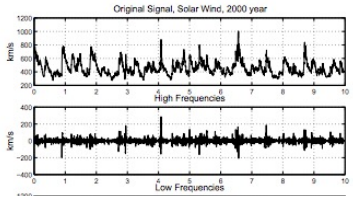
Solar Physics & Space Weather

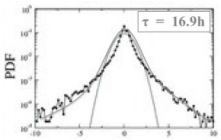
DOI:10.1126/science1235954

Advances in Space Research
Volume 32, Issue 6, September 2003, Pages 1175-1180

Nonlinear distribution of the sunspot magnetic field during the solar maximum

Reinaldo R. Rosa [1], Encarnacion A.M. Gonzalez-Machado [2], Heloisa M. Boechat-Roberty [2], Nandamudi L. Vijaykumar [1], Hanumant S. Sawant [3]

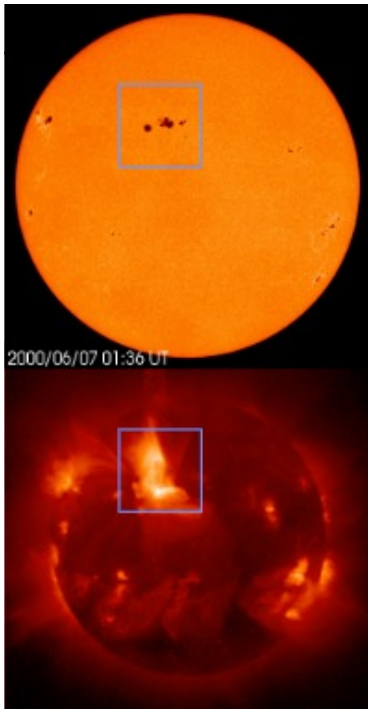


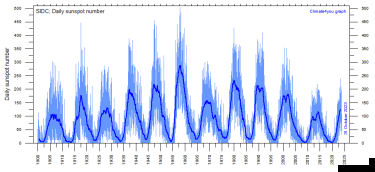


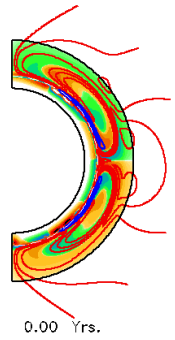
Journal of Atmospheric and Solar-Terrestrial Physics
Volume 67, Issues 17–18, December 2005, Pages 1843-1851

Generalized thermostatistics and wavelet analysis of solar wind and proton density variability

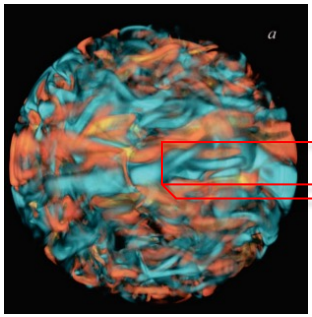
Maurício José Alves Bolzan [a], Reinaldo Roberto Rosa [b], Fernando Manuel Ramos [b], Paulo Roberto Fagundes [a], Yogeshwar Sahai [a]



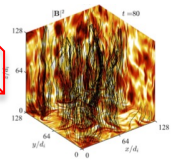


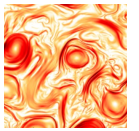


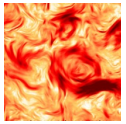
Ap.J 853,2018

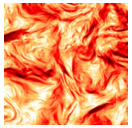


CAMELIA



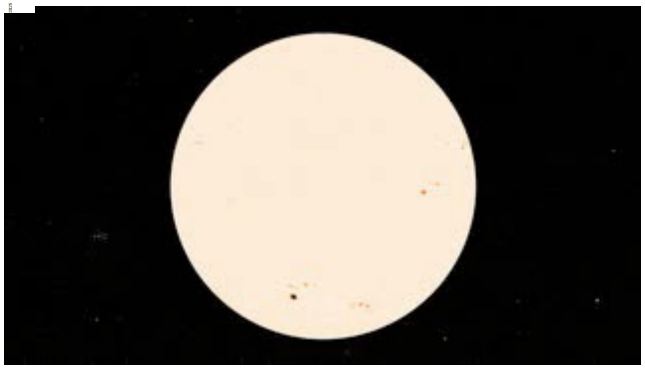






PLUTO
PENCIL

3D+1



Observational Cosmology ➔ Cosmological Large Scale Structure Formation (Millennium Simulation – Virgo Consortium)

Physica D: Nonlinear Phenomena
Volumes 168–169, 1 August 2002, Pages 404-409

Multiscaling and nonextensivity of large-scale structures in the Universe

F.M Ramos [a], C.A Wuensche [b], A.L.B Ribeiro [c], R.R Rosa [a]

$$S_q = k\frac{1-\sum_i^W p_i^q}{q-1} = \frac{k}{q-1}\sum_i^W (p_i - p_i^q)$$

$$\boxed{r \sim 1/(q-1)^\beta}$$

$$(q-1) \sim (1/r)^{1/\beta}, \text{ with } \beta > 0.$$

$$D_2(r) = 3\frac{\log(2 + a(1-q(r)))}{\log 2} \qquad a = 2S_q/k$$

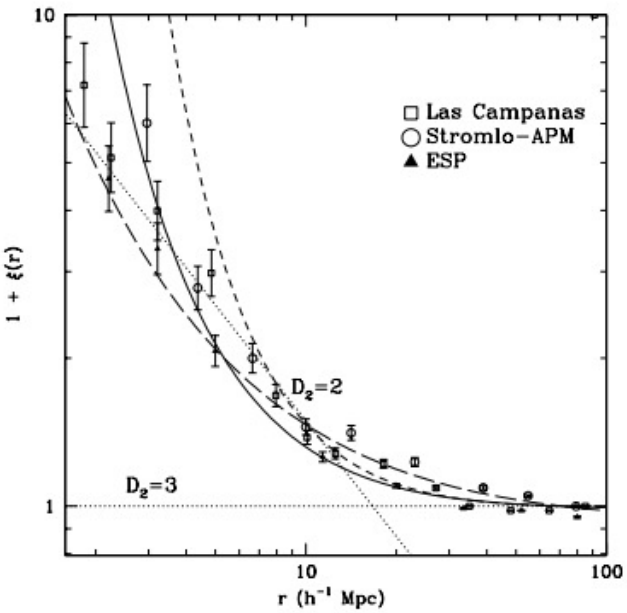
Physica A: Statistical Mechanics and its Applications
Volume 344, Issues 3–4, 15 December 2004, Pages 743-749

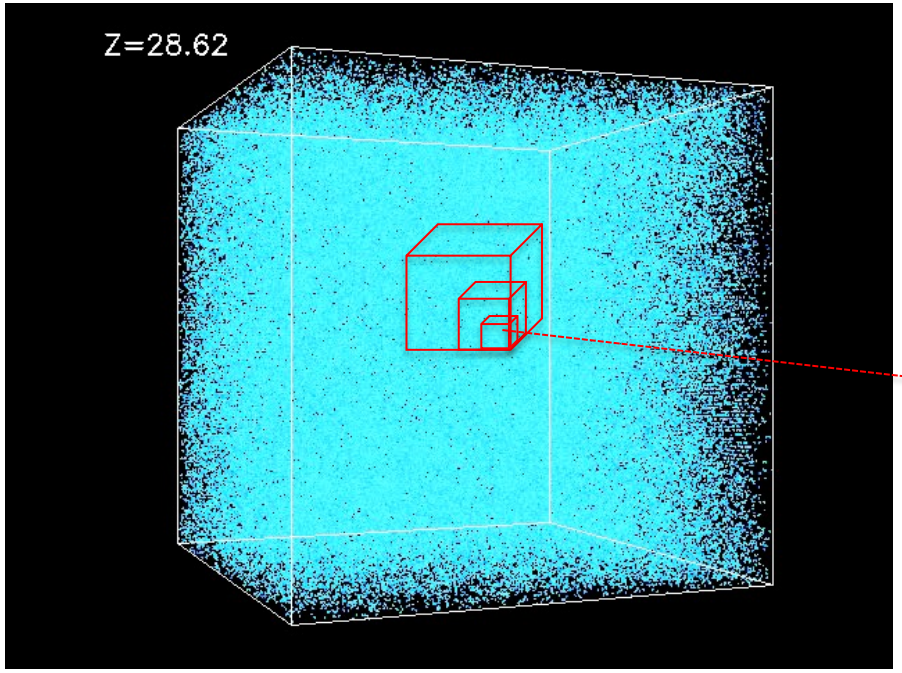
Nonextensivity and galaxy clustering in the Universe

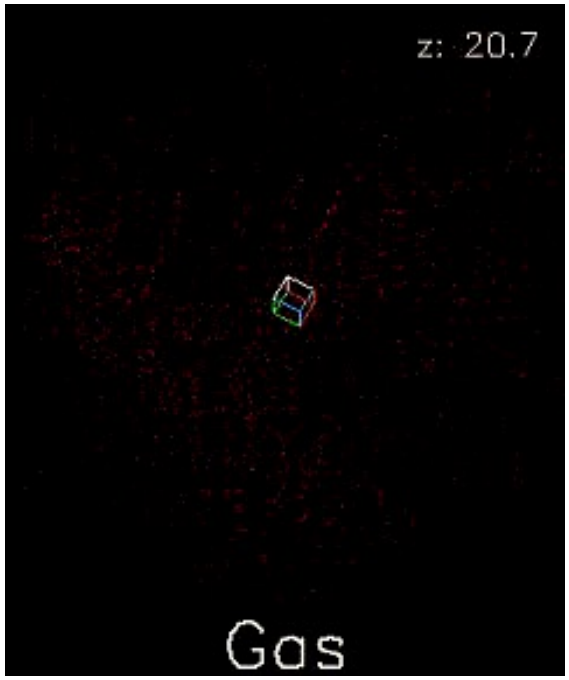
C.A. Wuensche [a], A.L.B. Ribeiro [b], F.M. Ramos [c], R.R. Rosa [c]

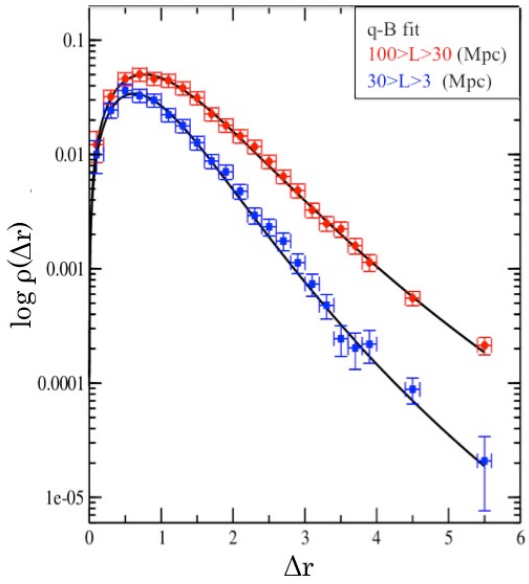
Show more

$$\boxed{1+\xi(r)=13D_2r^{(D_2-3)}}$$



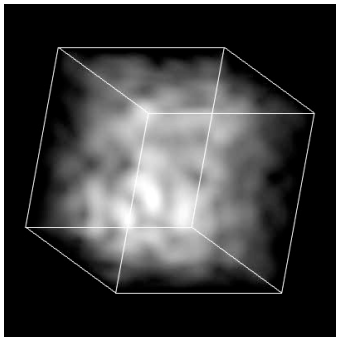

Z=28.62


z: 20.7
Gas


q-B fit
100>L>30 (Mpc)
30>L>3 (Mpc)
0.1
0.01
0.001
0.0001
1e-05
log ρ(Δr)
0
1
2
3
4
5
6
Δr

Characterizing Spatiotemporal Complex Patterns with GPA & Tsallis Spectral-Permutation Entropy

Reinaldo R. Rosa
Laboratório Associado de Computação e Matemática Aplicada
Coordenadoria de Pesquisa Aplicada e Desenvolvimento Tecnológico-COPDT
Instituto Nacional de Pesquisas Espaciais-INPE



Rubens Sautter-CAP-INPE
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Erico L. Rempel – ITA-CTA
Juan A. Valdivia – DF-U.Chile
Alejandro Flery – Un. Wellington, NZ

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FAPESP CNPq CAPES

Physica A: Statistical Mechanics and its Applications
Volume 283, Issues 1–2, 1 August 2000, Pages 156-159

Gradient pattern analysis of Swift–Hohenberg dynamics: phase disorder characterization

R.R Rosa [a], J Pontes [b], C.I Christov [1 d], F.M Ramos [a], C.Rodrigues Neto [a], E.L Rempel [a], D Walgraef [c]

JOURNAL ARTICLE

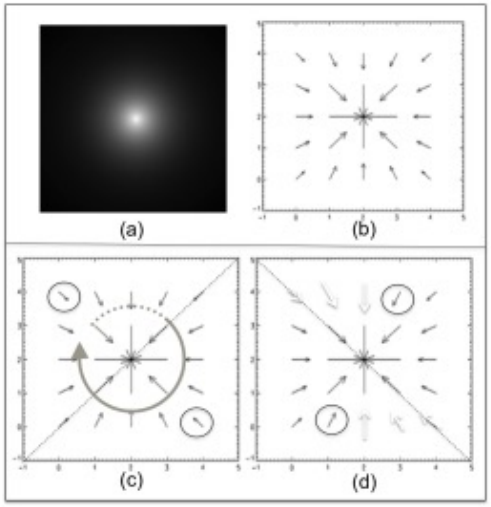
Gradient pattern analysis applied to galaxy morphology

R R Rosa, R R de Carvalho, R A Sautter, P H Barchi, D H Stalder, T C Moura, S B Rembold, D R F Morell, N C Ferreira

Monthly Notices of the Royal Astronomical Society: Letters, Volume 477, Issue 1, June 2018, Pages L101–L105, https://doi.org/10.1093/mnrasl/sly054

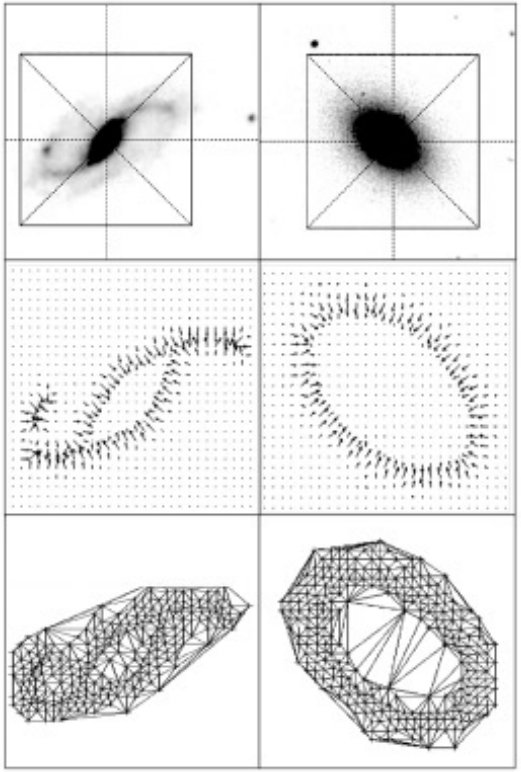
Acknowledgements

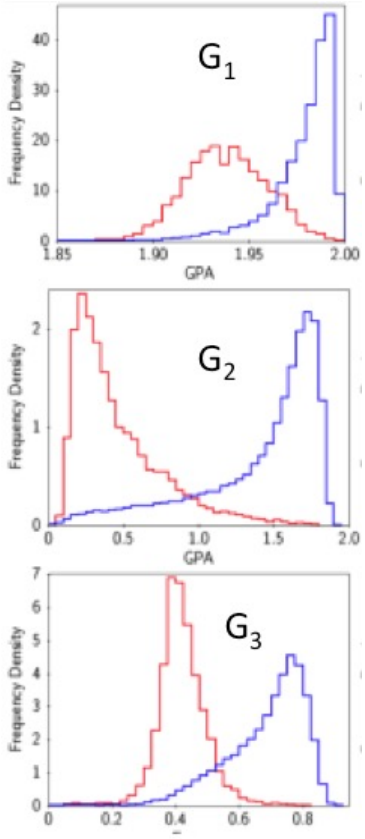
A.F.S. acknowledges support from the Brazilian Agency CNPq. R.R.R. is very grateful to the Brazilian Agency FAPESP under PROC 97/13374-1 and PROC 98/03104-0, and to F.M. Ramos, C. Rodrigues-Neto and C. Tsallis for discussions and valuable suggestions. L.S.R. acknowledges financial support from Luppa Engenharia e Sistemas and the Swedish Research Council for Engineering Science. E.V. is very grateful to support from the Danish Natural Science Research Council, the Carlsberg Foundation, Director…



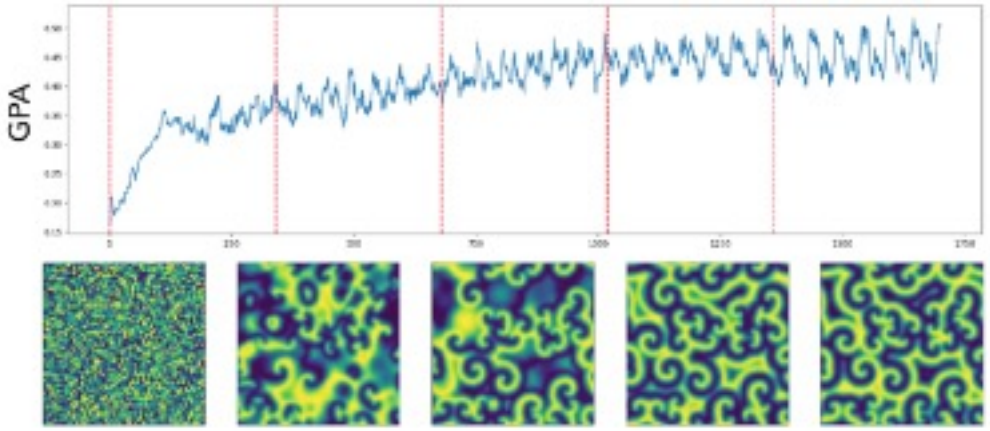
$$G_1 = \frac{T_A - V_A}{V_A}$$

$$G_2 = \frac{V_A}{V}\left(1 - \frac{\left|\sum_{i=0}^{V_A} v_i\right|}{2\sum_{i=0}^{V_A}|v_i|}\right)$$

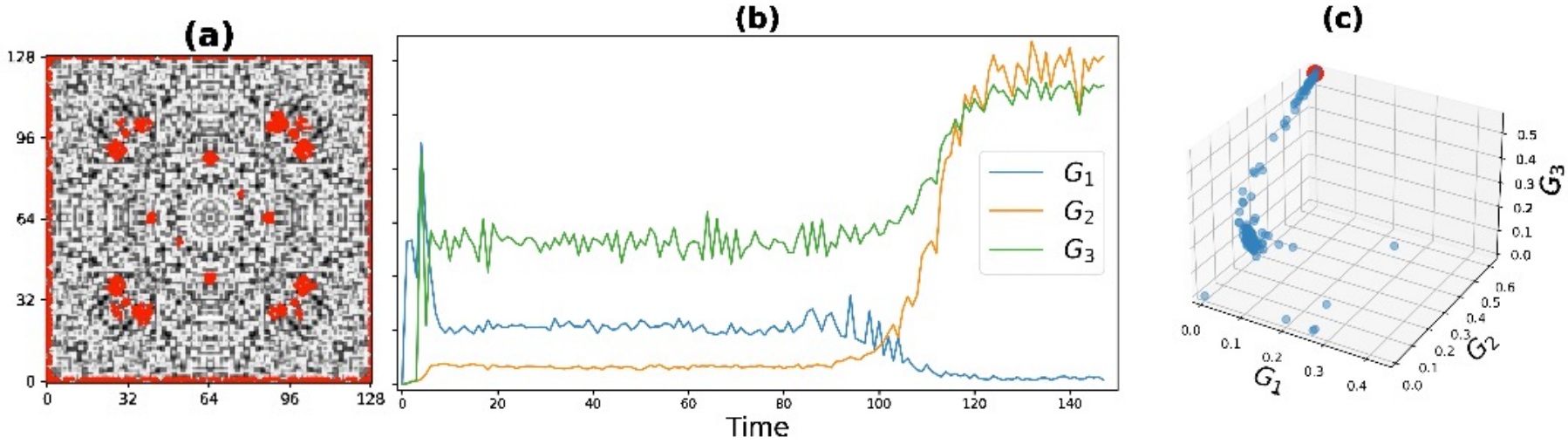




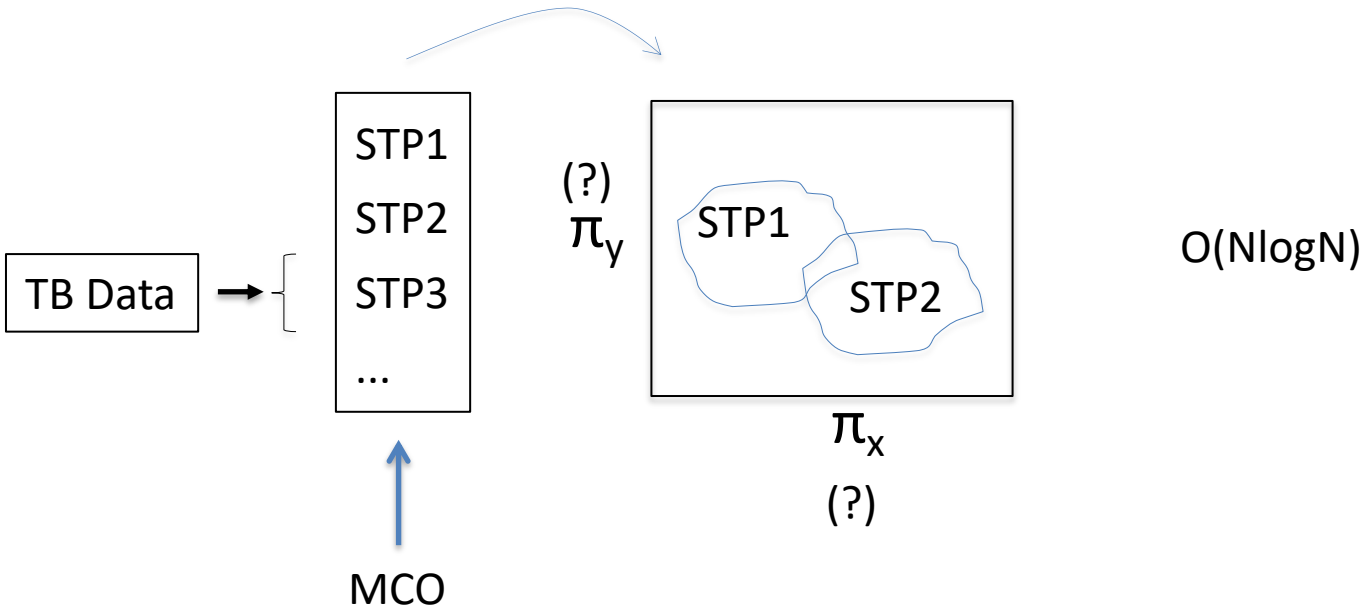
STP1



STP2



The Analytical Challenge



Physica A: Statistical Mechanics and its Applications
Volume 523, 1 June 2019, Pages 10-20

Multiscale Tsallis permutation entropy analysis for complex physiological time series

Chao li, Pengjian Shang

RESEARCH ARTICLE | JUNE 07 2021

ordpy: A Python package for data analysis with permutation entropy and ordinal network methods

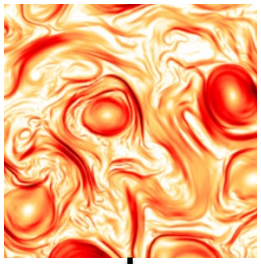
Arthur A. B. Pessa ; Haroldo V. Ribeiro

+ Author & Article Information
Chaos 31, 063110 (2021)
https://doi.org/10.1063/5.0049901 **Article history**

(http://github.com/arthurpessa/ordpy)

Input

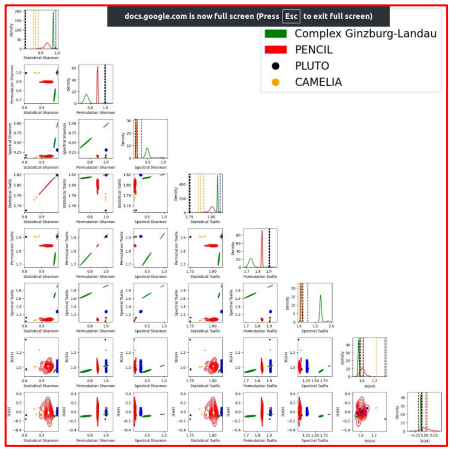
GPA

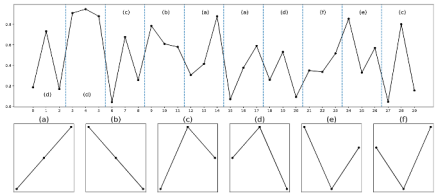


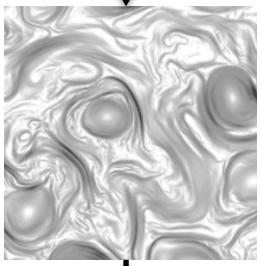
$G_4 = \sum_i P(v_i).\log(\frac{1}{P(\varphi_i)})$

G_4

Output







64^2

D!
(D=3, D=9)

p_i

Bandt & Pompe

$$S_H = -k\sum_{i=1}^{W} p_i \log p_i$$

Shannon
Pemutation

$$S_q = k\left(\frac{1-\sum_{i=1}^{W} p_i^q}{q-1}\right)$$

Tsallis
Pemutation

1D Vector (4096)

ORDpy
(sautter)

PSD

p_i

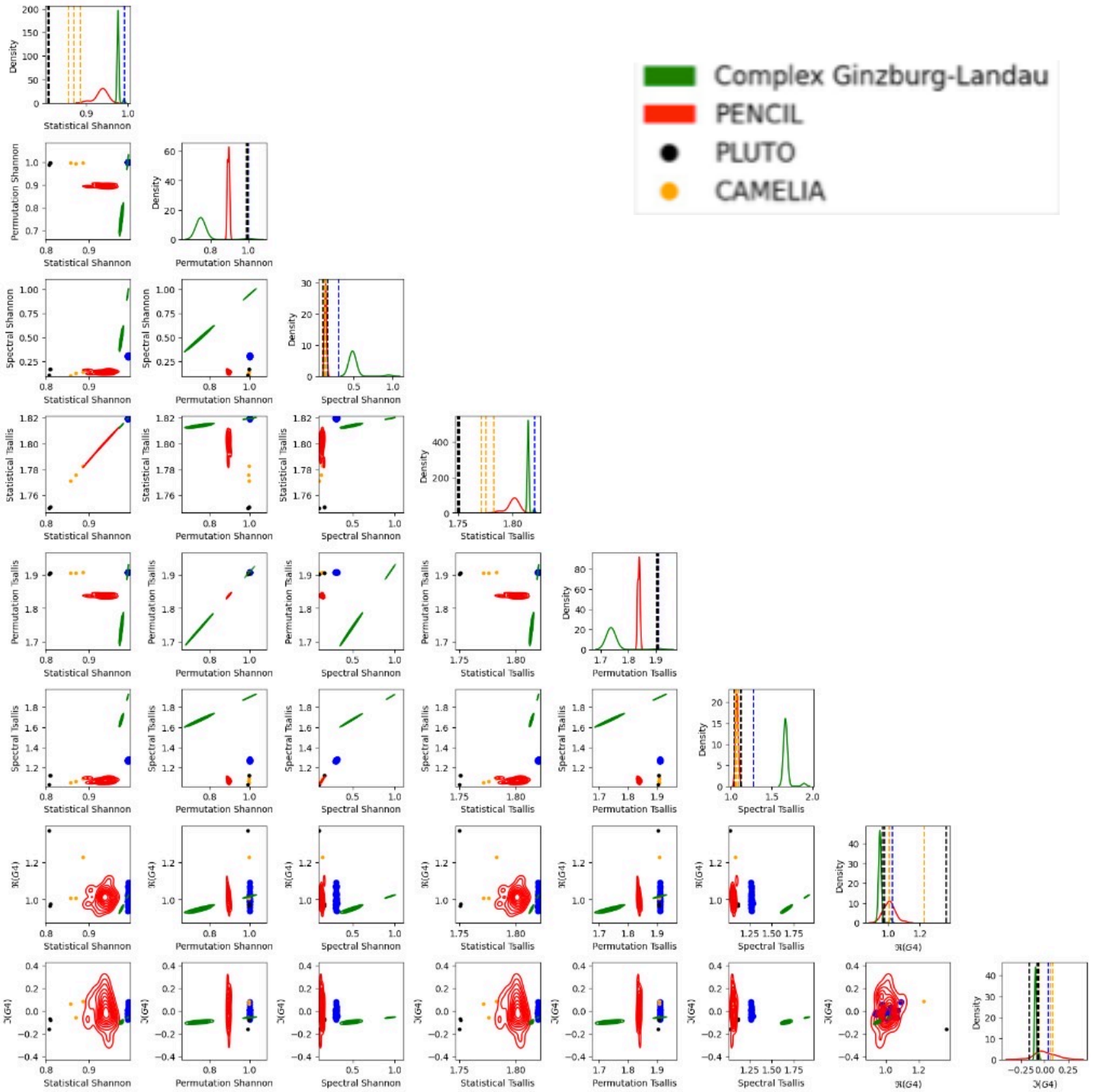
$$S_H = -k\sum_{i=1}^{W} p_i \log p_i$$

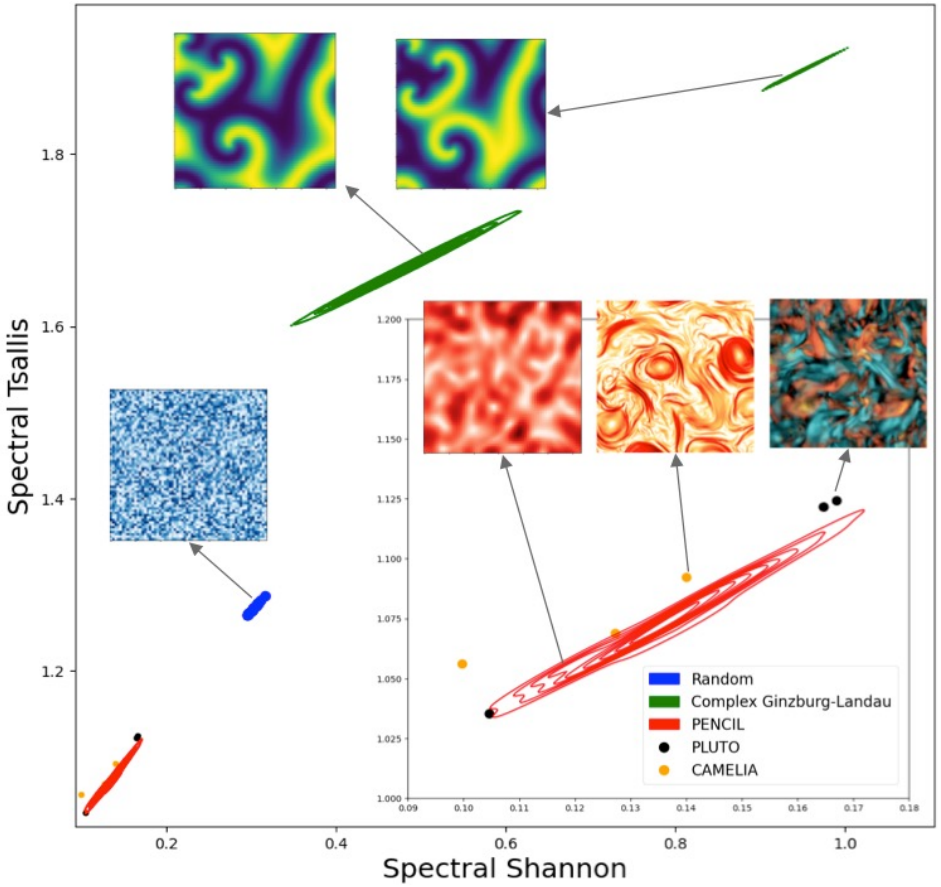
Shannon
Spectral

$$S_q = k\left(\frac{1-\sum_{i=1}^{W} p_i^q}{q-1}\right)$$

Tsallis
Spectral

p_i


Complex Ginzburg-Landau
PENCIL
PLUTO
CAMELIA
Density
Statistical Shannon
Permutation Shannon
Spectral Shannon
Statistical Tsallis
Permutation Tsallis
Spectral Tsallis
ℜ(G4)
ℑ(G4)

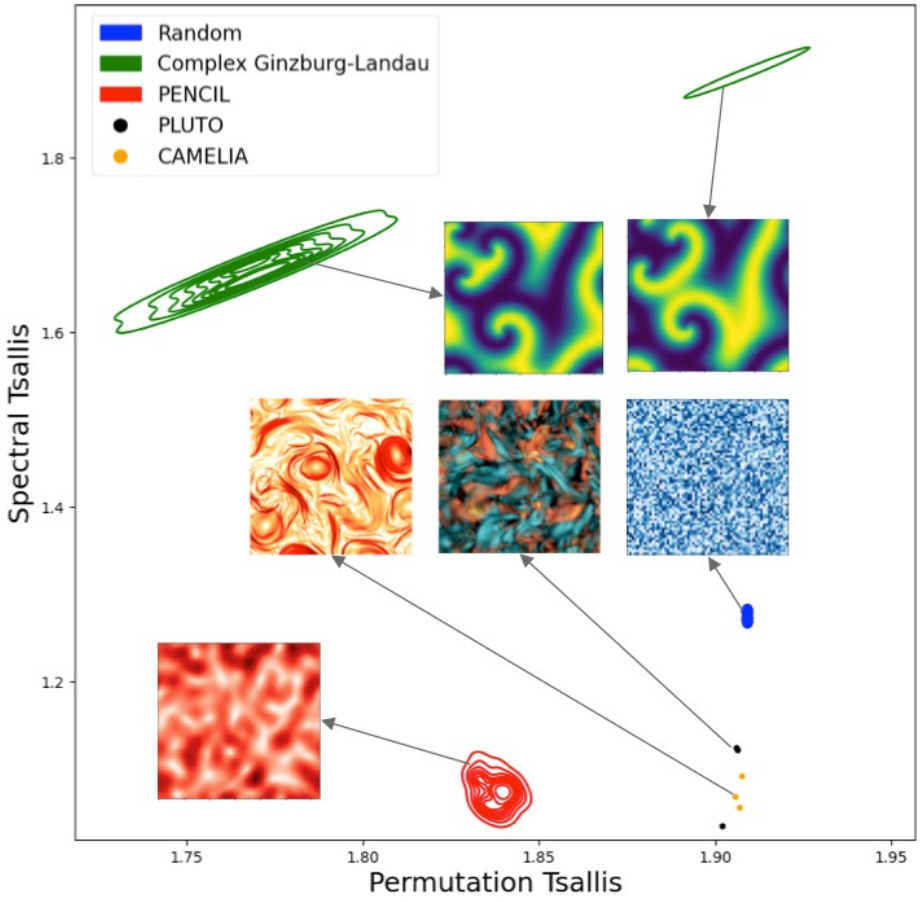


RTX4090 (<O>)

1GB/3.2x10^{-3}

1GB/6.5x10^{-1} (GPA)

1GB/1.2x10^{-3}



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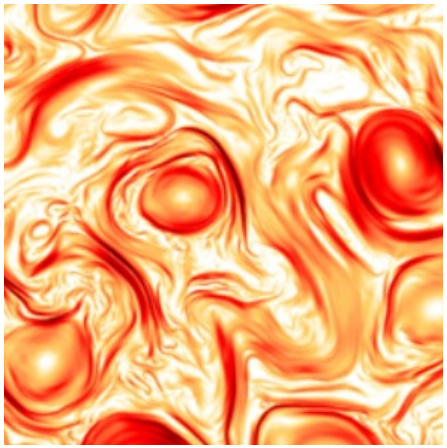
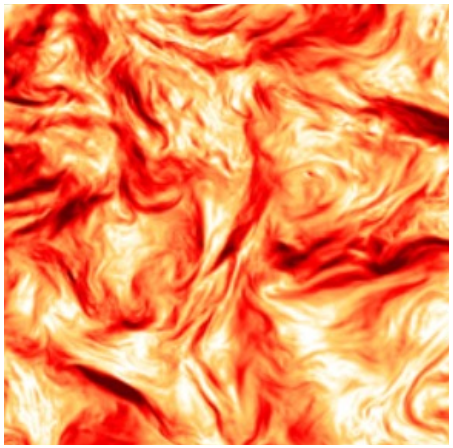
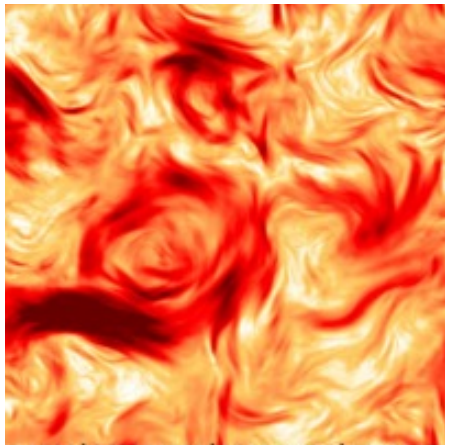
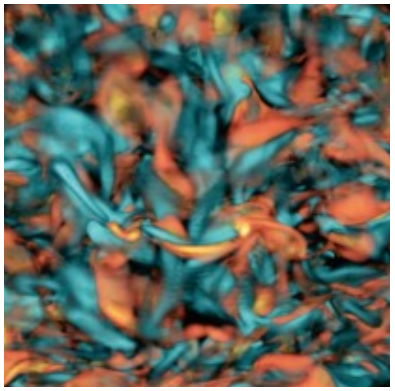
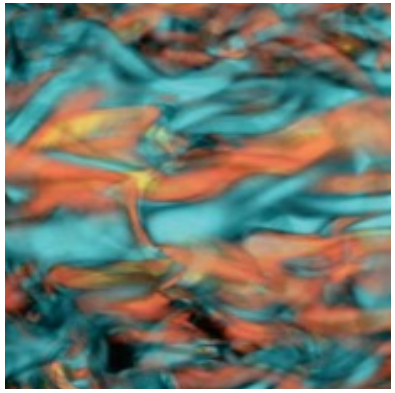
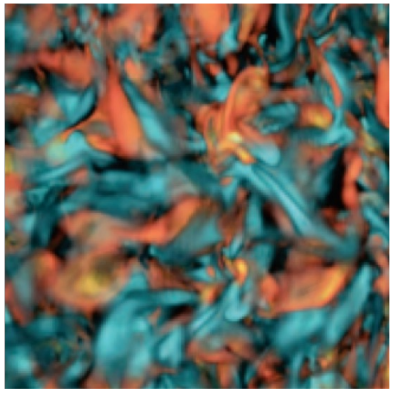
Future Work

- Massive Application Criteria
- Explicitly Marking Dynamics
- Labels for Deep Learning

I have learning on Non-additive Tsallis Fundamental Physics: Tear and Shear Processes

Constantino!!

MDPI

Article

Characterizing Spatiotemporal Complex Patterns with Tsallis Permutation Entropy

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Abstract: Complexity measures are important for understanding and analysing time series and one-dimensional profiles. However, the extension of these methods to two-dimensional data is still lacking. In the scope of physics, the problem of classifying complex 2D patterns is fundamental to some theoretical and applied fields, from quantum mechanics to cosmology. To achieve this objective, different tools can be used depending on the knowledge of the system and the quality and quantity of accessible data. In this work we selected different classes of structural patterns arising from 2D and 3D turbulent and chaotic processes to test the performance of Tsallis permutation entropy (TPE) as a classifier of complex textures. The results show that TPE is a valuable technique for analysing complex 2D patterns and that it is computationally faster than other techniques such as BPPE and GPA.

Keywords: spatiotemporal patterns; complexity measure; Tsallis permutation entropy; gradient pattern analysis