Abstract for GR-TR Conference on Statistical Mechanics and Dynamical Systems

Plenary Invited **Please specify a valid Type/Preference!**

Nonadditive entropy and nonextensive statistical mechanics - Recent predictions, verifications and applications

Constantino Tsallis*

Centro Brasileiro de Pesquisas Fisicas and
National Institute of Science and Technology for Complex Systems
Rua Xavier Sigaud 150, 22290-180 Rio de Janeiro-RJ, Brazil
and
Santa Fe Institute, 1399 Hyde Park Road, Santa Fe, NM 87501, USA
* Electronic Address: tsallis@cbpf.br

A plethora of natural, artificial and social systems exist which defy Boltzmann-Gibbs (BG) statistical mechanics in the sense that they do not satisfy the basic requirements for its validity. These are, for classical systems, ergodicity, positive maximal Lyapunov exponent (sufficient but not necessary for ergodicity), Markovian mesoscopic processes, and equivalent ones. Such complex systems can be handled in a variety of manners. However, if we wish to follow a statistical mechanical path, it appears to be necessary the use of nonconventional entropies such as the nonadditive one $S_q \equiv k\frac{1-\sum_i p_i^q}{q-1}$ ($q \in \mathcal{R}$; $S_1 = S_{BG} \equiv -k\sum_i p_i \ln p_i$). Important properties such as thermodynamical extensivity and finite entropy production per unit time can be achieved by tunnig the index q on precise values which reflect the dynamical/geometrical structure of occupancy of the Γ phase space (or Hilbert or Fock spaces, if quantum) of the system or, more precisely, of its nonextensivity universality class. This fact has also implications for the corresponding attractors in the sense of the Central Limit Theorem (q-generalized in [1, 2]). In addition to these conceptual aspects [3, 4], various recent predictions, verifications and applications will be briefly presented as well, in particular the recent ones achieved in the LHC and Brookhaven accelerators [5, 6, 7].

---

[1] S. Umarov, C. Tsallis and S. Steinberg, *On a q-central limit theorem consistent with nonextensive statistical mechanics*, Milan J. Math. **76**, 307 (2008).

[2] S. Umarov, C. Tsallis, M. Gell-Mann and S. Steinberg, *Generalization of symmetric α-stable Lévy distributions for $q > 1$*, J. Math. Phys. **51**, 033502 (2010).

[3] C. Tsallis, *Entropy*, in *Encyclopedia of Complexity and Systems Science*, ed. R.A. Meyers (Springer, Berlin, 2009), 11 volumes [ISBN: 978-0-387-75888-6].

[4] C. Tsallis, *Introduction to Nonextensive Statistical Mechanics - Approaching a Complex World* (Springer, New York, 2009).

[5] CMS Collaboration, *Transverse-momentum and pseudorapidity distributions of charged hadrons in pp collisions at $\sqrt{s} = 0.9$ and 2.36 TeV*, J. High Energy Phys. **02**, 041 (2010).

[6] CMS Collaboration, *Transverse-momentum and pseudorapidity distributions of charged hadrons in pp collisions at $\sqrt{s} = 7$ TeV*, 1005.3299 [hep-ex].

[7] PHENIX Collaboration, *Measurement of neutral mesons in $p + p$ collisions at $\sqrt{s} = 200$ GeV and scaling properties of hadron production*, 1005.3674 [hep-ex].