# Statistical mechanics for complex systems – News and views

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Boltzmann-Gibbs statistical mechanics is grounded on the celebrated Boltzmann-Gibbs-von Neumann-Shannon additive entropic functional $S_{BG}$. This outstanding theory is typically based on generically short-range space-time correlations and has been successfully verified along 150 years. However, during recent decades, experimental, computational and analytic evidences have grown up that it loses its applicability in the presence of generic long-range correlations. It was proposed in 1988 that, for such complex cases, statistical mechanics should be grounded on nonadditive entropic functionals, for instance Sq which depends on an index q and, for q=1, recovers $S_{BG}$. Recent applications of this generalized theory include (i)Tunnelling chemical reaction [Wild, Notzold, Simpson, Tran and Wester, Tunnelling measured in a very slow ion-molecule reaction, Nature (1 March 2023), doi: 10.1038/s41586-023-05727-z]; (ii)The numerical approach of the thermal transport properties of the n-vector d-dimensional inertial ferromagnet (n=1, 2, 3 for the Ising, XY and Heisenberg models respectively; d=1, 2, 3) and first-principle validation of Fourier's 1822 law [Tsallis, Lima, Tirnakli and Eroglu, First-principle validation of Fourier's law in d = 1, 2, 3, Physica D 446, 133681 (2023); Lima and Tsallis, Ising chain: Thermal conductivity and first-principle validation of Fourier law, arXiv 2303.13432]; (iii)The distribution of inter-occurrence times in human EEG [Abramov, Tsallis and Lima, Neural complexity – Statistical-mechanical approach of human electroencephalograms, arXiv 2303.03128 [q-bio.NC]]; (iv)Asymptotically scale-free networks with weighted links [Oliveira, Brito, Silva and Tsallis, Statistical mechanical approach of complex networks with weighted links, JSTAT 063402 (2022); Tsallis and Oliveira, Complex network growth model: Possible isomorphism between nonextensive statistical mechanics and random geometry, Chaos 32, 053126 (2022)]; (v)COVID-19 computer tomography [Al-Azawi, Al-Saidi, Jalab, Kahtan and Ibrahim, Efficient classification of COVID-19 CT scans by using q-transform model for feature extraction, PeerJ. Comput. Sci. 7, e553 (2021)]; (vi)AE in rock fractures [Vinciguerra, Greco, Pluchino, Rapisarda and Tsallis, Acoustic emissions in rock deformation and failure: New insights from q-statistical analysis, Entropy (2023), in press, doi: 10.20944/preprints202303.0462.v1]; (vii)q-generalized algebras and prime numbers [Borges, Kodama and Tsallis, Along the lines of nonadditive entropies: q-prime numbers and q-zeta functions, Entropy 24, 60 (2022)]; (viii)Decreasing entropy while increasing time [Tsallis and Borges, Time evolution of nonadditive entropies: The logistic map, arXiv 2211.03261 [cond-mat.stat-mech]]; (ix)Heavy quark dynamics [Megias, Deppman, Pasechnik and Tsallis, Comparative study of the heavy-quark dynamics with the Fokker-Planck Equation and the Plastino-Plastino Equation, arXiv 2303.03819 [hep-ph]]. Selected applications will be presented during the talk.