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Section Information:

The statistical physics section, broad and interdisciplinary in scope, intends to focus on the challenges of modern statistical physics and its applications to borderline problems while incorporating a high degree of mathematical rigor. Its aim is to provide a collection of high-quality research papers that meet the interest not only of physicists working in this field but also mathematicians and engineers interested in interdisciplinary topics. Generally, papers in pure statistics will not be accepted.

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Section Statistical Physics

Featured Papers

DOI:10.3390/e19070356

Clausius Relation for Active Particles: What Can We Learn from Fluctuations

Authors: Andrea Puglisi and Umberto Marini Bettolo Marconi

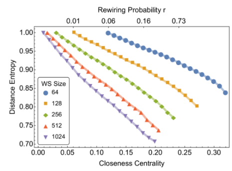
Abstract: Many kinds of active particles, such as bacteria or active colloids, move in a thermostatted fluid by means of self-propulsion. Energy injected by such a non-equilibrium force is eventually dissipated as heat in the thermostat. Since thermal fluctuations are much faster and weaker than self-propulsion forces, they are often neglected, blurring the identification of dissipated heat in theoretical models. For the same reason, some freedom—or arbitrariness—appears when defining entropy production. Recently three different recipes to define heat and entropy production have been proposed for the same model where the role of self-propulsion is played by a Gaussian coloured noise. Here we compare and discuss the relation between such proposals and their physical meaning. One of these proposals takes into account the heat exchanged with a non-equilibrium active bath: such an "active heat" satisfies the original Clausius relation and can be experimentally verified.

DOI:10.3390/e20040268

Distance Entropy Cartography Characterises Centrality in Complex Networks

Author: Massimo Stella and Manlio De Domenico

Abstract: We introduce distance entropy as a measure of homogeneity in the distribution of path lengths between a given node and its neighbours in a complex network. Distance entropy defines a new centrality measure whose properties are investigated for a variety of synthetic network models. By coupling distance entropy information with closeness centrality, we introduce a network cartography which allows one to reduce the degeneracy of ranking based on closeness alone. We apply this methodology to the empirical multiplex lexical network encoding the linguistic relationships known to English speaking toddlers. We show that the distance entropy cartography better predicts how children learn words compared to closeness centrality. Our results highlight the importance of distance entropy for gaining insights from distance patterns in complex networks.

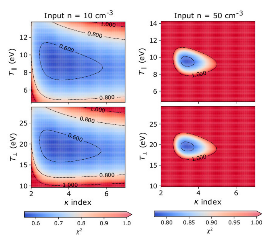


DOI:10.3390/e22010103

Determining the Bulk Parameters of Plasma Electrons from Pitch-Angle Distribution Measurements

Author: Georgios Nicolaou, Robert Wicks, George Livadiotis, Daniel Verscharen, Christopher Owen and Dhiren Kataria

Abstract: Electrostatic analysers measure the flux of plasma particles in velocity space and determine their velocity distribution function. There are occasions when science objectives require high time-resolution measurements, and the instrument operates in short measurement cycles, sampling only a portion of the velocity distribution function. One such high-resolution measurement strategy consists of sampling the two-dimensional pitch-angle distributions of the plasma particles, which describes the velocities of the particles with respect to the local magnetic field direction. Here, we investigate the accuracy of plasma bulk parameters from such high-resolution measurements. We simulate electron observations from the Solar Wind Analyser's (SWA) Electron Analyser System (EAS) on board Solar Orbiter. We show that fitting analysis of the synthetic datasets determines the plasma temperature and kappa index of the distribution within 10% of their actual values, even at large heliocentric distances where the expected solar wind flux is very low. Interestingly, we show that although measurement points with zero counts are not statistically significant, they provide information about the particle distribution function which becomes important when the particle flux is low. We also examine the convergence of the fitting algorithm for expected plasma conditions and discuss the sources of statistical and systematic uncertainties.



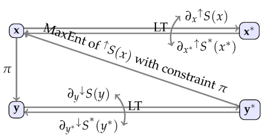
Featured Papers

DOI:10.3390/e21070715

Dynamic Maximum Entropy Reduction

Authors: Václav Klika, Michal Pavelka, Petr Vágner and Miroslav Grmela

Abstract: Any physical system can be regarded on different levels of description varying by how detailed the description is. We propose a method called Dynamic MaxEnt (DynMaxEnt) that provides a passage from the more detailed evolution equations to equations for the less detailed state variables. The method is based on explicit recognition of the state and conjugate variables, which can relax towards the respective quasi-equilibria in different ways. Detailed state variables are reduced using the usual principle of maximum entropy (MaxEnt), whereas relaxation of conjugate variables guarantees that the reduced equations are closed. Moreover, an infinite chain of consecutive DynMaxEnt approximations can be constructed. The method is demonstrated on a particle with friction, complex fluids (equipped with conformation and Reynolds stress tensors), hyperbolic heat conduction and magnetohydrodynamics.

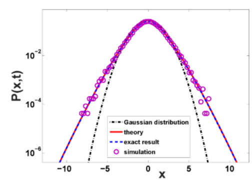


DOI:10.3390/e22060697

Large Deviations for Continuous Time Random Walks

Authors: Wanli Wang, Eli Barkai and Stanislav Burov

Abstract: Recently observation of random walks in complex environments like the cell and other glassy systems revealed that the spreading of particles, at its tails, follows a spatial exponential decay instead of the canonical Gaussian. We use the widely applicable continuous time random walk model and obtain the large deviation description of the propagator. Under mild conditions that the microscopic jump lengths distribution is decaying exponentially or faster i.e., Lévy like power law distributed jump lengths are excluded, and that the distribution of the waiting times is analytical for short waiting times, the spreading of particles follows an exponential decay at large distances, with a logarithmic correction. Here we show how anti-bunching of jump events reduces the effect, while bunching and intermittency enhances it. We employ exact solutions of the continuous time random walk model to test the large deviation theory.



Selected Topic Collection

Foundations of Statistical Mechanics
Collection Editor: Dr. Antonio M. Scarfone

This collection intends to present mainly theoretical oriented material (even purely mathematical) on the foundation of statistical mechanics. It focuses on the challenges of modern theory incorporating a high degree of mathematical rigor, in order to provide relevance not only to statistical physicists, but also to mathematicians and theoretical physicists. The papers submitted should have real and concrete applications in statistical mechanics, or provide clear evidence of possible applications.

Keywords:

- foundations of classical and quantum statistical mechanics
- Maxwell–Boltzmann, Bose–Einstein, and Fermi–Dirac statistics
- exotic statistics—Haldane, Gentile, and Quons
- generalizations of statistical mechanics
- non-Gibbsian distributions and power–law distributions
- statistical mechanics of non-equilibrium and meta-equilibrium—critical phenomena and phase transitions
- geometric foundations of statistical mechanics

Closed Special Issues

Theoretical Aspect of Nonlinear Statistical Physics
Guest editor: Prof. Dr. Giorgio Kaniadakis

Nonadditive Entropies and Complex Systems
Guest Editors: Prof. Dr. Andrea Rapisarda, Prof. Dr. Stefan Thurner and Prof. Dr. Constantino Tsallis

Physics of Ionic Conduction in Narrow Biological and Artificial Channels
Guest Editors: Prof. Peter V E McClintock and Dr. Dmitry G. Luchinsky

Entropy and Social Physics
Guest Editor: Dr. Krzysztof Malarz

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