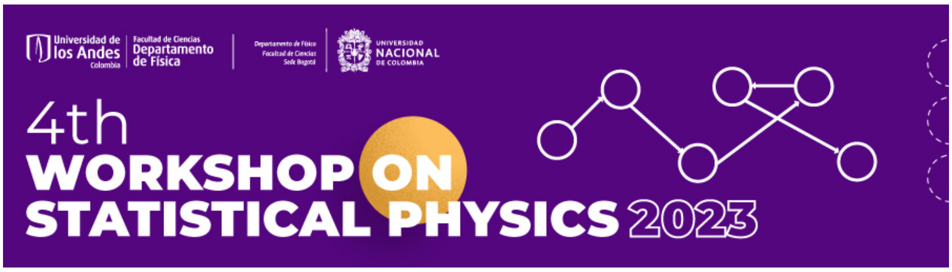

Contribution ID: **24** Tipo: **Poster**

Evolution of temporal fluctuation scaling exponent in non-stationary time series using supersymmetric theory of stochastic dynamics

jueves, 5 de octubre de 2023 17:40 (20 minutos)

Fluctuation scaling is an emergent property of complex systems that relates the variance (Ξ) and the mean (Υ) from an empirical data set in the form $\Xi\sim\Upsilon^{\alpha_{TFS}}$, where the dispersion (fluctuation) of the data has been described in terms of Ξ. Taking into account the path integral formalism developed by H. Kleinert, we extend the path integral formalism in the context of the supersymmetric theory of stochastic dynamics to understand the origin of the temporal fluctuation scaling and the evolution of its exponent over time $\alpha_{TFS}(t)$. To this end, we first show how the probability of transition between two states of a stochastic variable $x(t)$ can be expressed once it is known its cumulant generating function $H(p)$. Thus, introducing a non-linear term in cumulant generating function $\mathcal{H}^{(n)}(p,t;\gamma)$ leads to a model where the n-th moment of the probability distribution evolves arbitrarily. Subsequently, in order to reproduce the temporal fluctuation scaling, a linear combination of $\mathcal{H}^{(n)}(p,t;\gamma)$ with $n\in\{1,2\}$ is used. Therefore, this allows describing how the mean $M_1(t)$ and the variance $\Xi_2(t)$ of empirical time series evolve. Thence, an analytical expression is deduced for the evolution of the temporal evolution of the temporal fluctuation scaling exponent $\alpha_{TFS}(t)$. Additionally, this approach is verified in different financial time series with a daily frequency.

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Session Classification: Poster session

Track Classification: Statistical Physics