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

Talk Invited Invited Talk

Environmental noise and nonlinearity in biological and physical systems

B. Spagnolo*

Dipartimento di Fisica, Group of Interdisciplinary Physics, Universit di Palermo and CNISM Viale delle Scienze pad. 18, I-90128 Palermo, Italy
* Electronic Address: bernardo.spagnolo@unipa.it

The role played by environmental noise in the dynamics of biological and physical systems has been a subject of growing interest and investigation in recent years. Here we show the interplay between environmental noise sources and nonlinearity of the system investigated in three different biological and physical systems. (i) The role of a non-Gaussian Levy noise on the nonlinear transient dynamics of a short overdamped Josephson junction is analyzed. The mean escape time of the junction is investigated considering Gaussian, Cauchy-Lorentz and Levy-Smirnov probability distributions of the noise signals. In these conditions we find resonant activation and the first evidence of noise enhanced stability in a metastable system in the presence of Lvy noise. For Cauchy-Lorentz noise source, trapping phenomena and power law dependence on the noise intensity are observed [1]. (ii) The phenomena of dissonance and consonance in a simple auditory sensory model composed of three neurons are considered. Two of them, here so-called sensory neurons, are driven by noise and subthreshold periodic signals with different ratio of frequencies, and its outputs plus noise are applied synaptically to a third neuron, so-called interneuron. We propose a theoretical analysis with a probabilistic approach to investigate the interspike intervals (ISI) statistics of the spike train generated by the interneuron. We find that at the output of the interneuron, inharmonious signals give rise to blurry spike trains, while the harmonious signals produce more regular, less noisy, spike trains. Theoretical results are compared with numerical simulations [2]. (iii) Finally the dynamics of a quantum particle subject to an asymmetric bistable potential and interacting with a thermal reservoir is investigated. We obtain the time evolution of the population distributions in the position eigenstates of the particle, for different values of the coupling strength with the thermal bath. The calculation is carried out by using the Feynman-Vernon functional under the discrete variable representation [3].

---

[1] Giuseppe Augello, Davide Valenti, Bernardo Spagnolo, Non-Gaussian noise effects in point Josephson junctions, Eur. Phys. J. B 78, 225234 (2010).

[2] Yu.V. Ushakov, A.A. Dubkov and B. Spagnolo, Regularity of spike trains and harmony perception in a model of the auditory system, Physical Review Letters 107, 108103 (4) (2011).

[3] B. Spagnolo, P. Caldara, A. La Cognata, D. Valenti, A. Fiasconaro, A. A. Dubkov, G. Falci, The bistable potential: an archetype for classical and quantum systems, Int. J. Mod. Phys. B 26, 1241006 (2012). .