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SEMINÁRIO DE FÍSICA-MATEMÁTICA

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"Khinchin Theorem and Anomalous Diffusion."[1]

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Abstract

A recent paper [1] has called attention to the fact that irreversibility is a broader concept than ergodicity, and that therefore the Khinchin theorem (KT) may fail in some systems. In this work [2], we have shown that the KT (proved by Khinchin for normal diffusion) holds for all kinds of diffusive processes, which are ergodic in the range of diffusive exponents $0 < \alpha < 2$ [2, 3]. This result may have deep consequences in many areas. Moreover, it could be verified and applied to experimental systems, such as the electron subdiffusive dynamics within a single protein molecule, which has recently been modelled by a Generalized Langevin Equation (GLE). Such a model successfully explains the equilibrium fluctuations and its broad range of time scales, being in excellent agreement with experiments. The KT gives the Ergodic Hypothesis a practical character, since it is expressed in terms of response functions: our results apply for real-valued relaxation functions R(t); on the other hand, if the relaxation function assumes complex values, e.g. conductivity, the final value theorem may not be applied. For those systems, and the KT fails, as proposed in Ref. [1]. In principle, it is generally possible to derive a GLE for Markovian systems by eliminating variables, whose effects are incorporated in the memory kernel and in the colored noise. Altogether, some results obtained for the GLE formalism should be valid for diffusion described by fractional Fokker-Planck equations, since both formalisms yield similar results. The violation of ergodicity may leed to the lack of a detailed balance relation wich may require a specific analysis of each case [2, 4]. Further research in this direction is needed and will open new perspectives.

References

[1] M. H. Lee, Phys. Rev. Lett. 98, 190601 (2007).

[2] L. C. Lapas et al., Phys. Rev. Lett. 101, 230602 (2008).

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[4] L. C. Lapas et al., Europhysics Lett. 77, 37004 (2007).

[1] Work in collaboration with Luciano C. Lapas and J. Miguel Rubi

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