Microscopic chaos, fractals and transport in nonequilibrium statistical mechanics

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Abstract

A fundamental problem of statistical physics is to understand the emergence of irreversible macroscopic transport starting from reversible microscopic dynamics. This requires to model the interaction of a subsystem with a thermal reservoir. A simple example is a tracer particle in a fluid exhibiting Brownian motion for which there is the famous description in terms of a stochastic Langevin equation. Four decades ago scientists proposed a fully deterministic, time reversible modeling of thermalized motion by deriving a generalized Hamiltonian formalism yielding generalized friction coefficients. Surprisingly, in nonequilibrium situations such as, e.g., under an external electric field, this time reversible dissipative dynamics generates fractal attractors, exhibits an identity between phase space contraction and entropy production, and furnishes formulas that express transport coefficients in terms of Lyapunov exponents. In my talk I will show how this class of dynamical systems is constructed, will review its basic properties, and will critically discuss a conjectured universality of its properties.

[1] R.Klages, Microscopic Chaos, Fractals and Transport in Nonequilibrium Statistical Mechanics (World Scientific, Singapore, 2007)