Irreversible transport from time reversible dissipative chaotic dynamics

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Abstract

In this talk I will outline a theory that aims at understanding the emergence of irreversible macroscopic transport starting from reversible microscopic dynamics. At the heart of this approach is to suitably 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 well-known description in terms of stochastic Langevin dynamics. Three decades ago scientists proposed a fully deterministic, time reversible modeling of thermalized motion by deriving a generalized Hamiltonian formalism yielding generalized friction coefficients in terms what is called Gaussian and Nosé-Hoover thermostats. 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 dynamical systems properties, and will critically discuss a conjectured universality of these properties. I will present a rather general summary of this approach, not much pre-knowledge about this particular field of research is required.

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