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The study of dynamic singularities of seismic signals by the generalized Langevin equation

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ABSTRACT

Analytically and quantitatively we reveal that the generalized Langevin equation (GLE), based on a memory function approach, in which memory functions and information measures of statistical memory play a fundamental role in determining the thin details of the stochastic behavior of seismic systems, naturally leads to a description of seismic phenomena in terms of strong and weak memory. Due to a discreteness of seismic signals we use a finite–discrete form of the GLE. Here we studied some cases of seismic activities of Earth ground motion in Turkey with consideration of the complexity, nonergodicity and fractality of seismic signals.

1. Introduction

Specific stochastic dynamics occur in a large variety of systems, such as supercooled liquids, seismic systems, the human brain, finance, meteorology and granular matter. These systems are characterized by an extremely rapid increase or a slowdown of relaxation times and by a non-exponential decay of time-dependent correlation functions [1,2].

The canonical theoretical framework for stochastic dynamics of complex systems is the time-dependent generalized Langevin equation (GLE) [3–7,14,15]. It successfully describes the phenomenon of statistical memory, whereby the relaxation time for order parameter fluctuations scales as a power of the correlation length. An obvious question to ask would be whether this framework can be adapted to describe seismic phenomena. Analytically and quantitatively we show that the GLE, based on a memory function approach, where the memory functions and information measures of statistical memory play a fundamental role in determining the thin details of the stochastic behavior of seismic systems, naturally leads to a description of seismic phenomena in a terms of a strong and weak memory. Due the discreteness of a seismic signals we use a finite–discrete form of the GLE. Here we study some cases of seismic activities of Earth ground motion in recent years in Turkey with consideration of the complexity, irregularity and metastability of seismic signals.

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