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Time Between the Maximum and the Minimum of a Stochastic Process

The properties of extremes of a stochastic process/time series of a given duration T are of fundamental importance in describing a plethora of natural phenomena. For example, this time series may represent the amplitude of earthquakes in a specific seismic region, the amount of yearly rainfall in a given area, the temperature records in a given weather station, etc. The study of extremes in such natural time series have gained particular relevance in the recent context of global warming in climate science. In many applications it is important to estimate when the extremal values will be reached. For instance, in finance one wants to predict the time at which the price of a stock will reach its maximal value. In this work we consider the time-difference τ between the global minimum and the global maximum for a variety of stochastic processes. We present an exact solution for the probability density function of τ in the cases of one-dimensional Brownian motion and Brownian bridge (a periodic Brownian motion of period T). We demonstrate that these results can be directly applied to study the position-difference between the minimal and the maximal height of a fluctuating $(1 + 1)-$dimensional Kardar-Parisi-Zhang interface on a substrate of size L, in its stationary state. Numerical simulations are in excellent agreement with our theoretical findings.

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