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The long-range correlation of the rock surface

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Abstract

Recently, the study of physical systems displaying long-range power-law correlation has attracted considerable attention. In this paper, we propose a two-dimensional method based on auto-correlation function method to detect the long-range correlation of the two-dimensional surface. The generalization is adopted to analyze the rock surface and nice scaling laws are unraveled.

Key words: *Auto-correlation function, Long-range correlation, Rock surface*

1. Introduction

The surface topography of a rock fracture plays a dominant role in the mechanical and hydraulic behavior of discontinuous rock masses. The mechanical properties of rock mass are greatly dependent on surface roughness and fracture geometry of rock joints (Kulatilake *et al*., 1995; Grasselli and Egger, 2003; Zhou and Xie, 2004). Therefore, correct evaluation of mechanical behavior of rock joints is required. In order to study the characteristic, several criteria have been proposed to identify the strength of a rough rock joint in the present work. For example, Barton's criterion considers the influence of the roughness on shear strength by introducing a morphological parameter known as the joint roughness coefficient (Grasselli and Egger, 2003; Barton *et al*., 1978). Characterizations of surface roughness of rock joints, such as heterogeneity and anisotropy can be investigated by fractal analysis. To estimate the fractal dimension of fracture surfaces, a direct three-dimensional fractal measurement method, the projective covering method, is applied to directly estimate the real fractal dimension for a rock joint surface (Xie, 1993; Wang and Xie, 1996).

There is growing evidence that output signals of many physical systems can be characterized by long-range power-law correlations (Zheng *et al*., 2001; Watters and Martin, 2004; Jordan *et al*., 2006; Yokogawa *et al*., 2009; Karkare *et al*., 2009). For this purpose, we consider a record {x(i)} of i = 1, . . . , N equidistant measurements, where the index i is usually correspond to the time of the measurements. We are interested in the correlation of the values x(i)and x(i+s) for different time lag s, i. e. correlations over different time scales s. Quantitatively, correlations between x-values separated by s steps are defined by the auto-correlation function (Yang *et al*., 2004; Chiang *et al*., 2003; Vauchot *et al*., 2004). In this paper, we generalize the auto-correlation function method from one-dimensional to high-dimensional version. The generalized method is applied to the rock surface and found that the auto-correlation exist in this series.

The paper is organized as follows. Firstly, the one-

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