Fractality in selfsimilar minimal mass structures

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Abstract

In this paper we study the diffusely observed occurrence of Fractality and Self-organized Criticality in mechanical systems. We analytically show, based on a prototypical compressed tensegrity structure, that these phenomena can be viewed as the result of the contemporary attainment of mass minimization and global stability in elastic systems.

Keywords: Global stability, Mass optimization, Fractal dimension, Self-organized Criticality (SOC), Tensegrities

Introduction

In recent years the experimental evidence of fractal systems has increasingly interested many technological and theoretical fields of research [11]. Nowadays, Fractality is recognized as a paradigm of material and structure morphological optimization. Indeed, through billions years evolution, nature developed complex, hierarchical multiscale structures delivering performances unreached by human technologies [8]. Typical examples of natural hierarchical systems are represented by spider silks [5], geckoes pads [15], and keratin materials that attain their incredible properties based on the creation of multiscale structure morphologies, often characterized by self-similarity [7]. The study of the physical mechanisms underlying the diffuse experimental observation of fractal systems is important understanding fundamental features of many nature and biological phenomena and is also crucial for the design of new efficient bioinspired materials and structures.

In this paper, we are interested in an explicit theoretical understanding of why nature shapes materials and structures in self-similar systems. In