Chapter

Introductory Chapter: Fractal in Sciences

Sid-Ali Ouadfeul

1. Introduction

The notion of fractal was introduced for the first time in 1975 by the mathematician Benoit Mandelbrot in his book entitled *Fractal Objects* which marked the beginning of his fame. The first definitions of the adjective fractal (from the Latin adjective fractus) come from the word "frangere" which means to break.

The irregularities of nature, of chaotic appearance, such as the irregularities of the seacoasts and the shape of the clouds, a tree, and a fern leaf, are in fact the expression of a very complex geometry of the sea. 'infinitely small. It can be said, however, that a fractal object is an invariant object by dilations, translations, and rotations [1].

The fractal analysis has been widely used in sciences, for example, in physics, the fractal analysis is used in thermodynamics, particularly for the study of fully developed turbulence [1], in image segmentation and processing [2, 3], in astrophysics for the study of hydrogen distribution [4], in physical medicine for tumor localization from mammograms [3], and in cardiology, for the study of the electrocardiograms [5].

In geoscience, the fractal analysis has been used in petrophysics for the segmentation or classification of geological formations [6–9]. It has also been used in geomagnetism to characterize the outer part of the geomagnetic field [10–14]. In environmental sciences, Burrough [15] used the semivariogram method to estimate the fractal dimension D for various environmental transects (e.g., soil factors, vegetation cover, iron ore content in rocks, rainfall levels, crop yields). In medicine and human biology, the fractal analysis has been applied in cell, protein, and chromosome structures, for example, Takahashi [16] supposed that the basic design of a chromosome has a tree-like pattern. Xu et al. [17] assumed that the twistings of DNA-binding proteins have fractal properties. Self-similarity has recently demonstrated in DNA sequences (see Stanley [18]; see also papers in Nonnenmacher et al. [19]). Glazier et al. [20] used the multifractal spectrum approach to rebuild the evolutionary history of organisms from mDNA sequences.

The aim of this book is to gather advance researches in the field of fractal analysis; the book contains seven chapters: one chapter is discussing the Parrondian games in discrete dynamic systems, two chapters are debating the application of the fractal analysis in microwave and antennas, and another chapter is showing some applications in medicine, while another one is talking about the fractal structures of the carbon nanotube system arrays and another chapter discuss the methods and challenges of the fractal analysis of the time-series data sets.

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Author details

Sid-Ali Ouadfeul
University of Khemis Miliana, Algeria

*Address all correspondence to: souadfeul@ymail.com

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