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Analysis lunar maps using multifractal method

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Abstract

 The aim of the present work is to develop a fractal method for space maps analysis. Although there are accurate theories of lunar motion in the dynamic coordinate system based on lunar laser ranging and space measurements with an accuracy up to multiarcseconds, analysis of various models of the lunar figure is a complicated problem. The reason for it is that the determination of a reference system for coordinate data and assessing its authenticity are difficult. In order to solve the problem, a comparative method, in which the structure of altitude vectors associated with same lunar coordinates is used, may be applied. However, the application of such method requires conduction of a large number of measurements and calculations. Besides, there are a lot of models of the librational zone of the Moon constructed by various methods, so the accuracy of this data is controversial. In other words, the relief of the Moon is of very complicated structure and the application of traditional methods in most cases is unacceptable. At the same time, physical surfaces of celestial bodies are fractal objects. The study of such objects using fractal methods allows not only investigating its structure, but the connection between the structure and processes of its formation as well. Thereby, the development of methods of identifying and analyzing nonlinear complex systems is a subject of great interest. It should be noted that analysis of celestial bodies macrosurfaces based on the study of fractal similarity coefficients has not been conducted in the world practice before. This fully applies to selenography. On the basis of the new method, a comparative analysis of modern lunar maps similarity (maps include altitude isohypses constructed according to ground-based and space observations) was conducted. For 2 models of the lunar librational zone the lunar macrofigure variations were determined using the fractal similarity factors and fractal dimensions. The Moon’s macrofigure models have been built on the basis of harmonic analysis and expansion of altitude data from the dynamic selenocentric catalogue in a series of spherical functions. As a result, the values of fractal dimensions of the lunar relief anomalies for 8 zones of Hayn latitudes are determined. The mean fractal dimension for the lunar librational zone has been obtained. This value is $d = 1,345$. For the above mentioned areas the fractal similarity factors are obtained. Based on the analysis of the fractal similarity factors for various lunar surface models one may draw a conclusion on how similar these models are when analyzing maps.

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Keywords

Fractal analysis, Lunar dynamical coordinate system, Maps of the Moon, Physical surfaces of

celestial bodies

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