MODELING THE LUNAR PHYSICAL PARAMETERS USING COMPLEX SYSTEMS METHODS

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Introduction: Analysis of spin-orbital evolution and tidal dissipation of the multilayered Moon [1], construction appropriate analytical and numerical theories of the Moon's rotation and, subsequently, other multilayered bodies of the Solar system [2], considering the effects of tidal dissipation and the impact of processes occurring at the core-mantle boundary on the rotation of the planet [3], applying the results of theoretical researches to processing of modern high precision observations to provide a number of space missions to the Moon are the modern and urgent tasks [4].The aim of this work is analysis of stochastic and dynamical features of time series describing the satellite measurements of gravitational fields and parameters of lunar physical libration (LPL) [5]. Developed the modern methods of multi-parameter analysis, revealing types of interrelationships and cross-correlations, statistical memory effects, providing a certain level of stochastic and frequency- phase similarity for the future determination of LPL statistical parameters for objects being studied [6, 7].

Methods: New methods of processing and analyzing time series were developed on the basis of modern achievements of nonequilibrium statistical physics of complex systems [8]. The methods were developed to generalize theoretical approaches to the case of a local-temporal description [9] — an analysis of local samples of optimal time duration and an investigation of event correlations realized in non-equidistant time series recorded with a random sampling step in a series of satellite observations of the LPL and a method was developed analysis of complex multi-parameter systems based on the determination of fractal dimensions and fractal coefficients of self-similarity [10, 11].

Results: Computer programs were developed for the reduction of satellite observations [12]. The software package “Automated coordinate transformation system” (ASTC) was created [13]. The software modules included in the ASTC allow the solution of overdetermined and normal systems of conditional linear algebraic equations [14]. There is the possibility of using step-by-step regression analysis, which is used to obtain a model with fewer observations [15]. When modeling observations from the lunar surface, a program complex developed by the authors of the project built on the basis of the analytical theory of LPL is used.

Conclusions: Applying the modern methods of multi-parameter analysis allowed revealing types of interrelationships and cross-correlations, statistical memory effects, providing a certain level of stochastic and frequency-phase similarity for the accurace determination of selenophysical parameters for objects being studied [16]. The work is relevant because new high-precision models and methods of LPL analysis were devel-oped on the basis of modern experimental data, obtained during space investigations of the Moon, and modern methods of planetary geodesy. It help to significantly improve the navigational support and increase the accuracy of landing on the Moon’s surface for descent modules of planned space lunar missions [17].

Acknowledgements: This work was partially supported by Russian Science Foundation, grants no. 20-12-00105 (according to the grant, the method for data analysis was created) and 21-72-10024 (the numerical calculations were carried out). This work is performed according to the Kazan Federal University Strategic Academic Leadership Program. This work was partially supported by the Russian Foundation for Basic Research grant no. 19-32-90024 and the Foundation for the Advancement of Theoretical Physics and Mathematics “BASIS”.

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