THE AUTOMATED STOCHASTIC ANALYTICAL COMPLEX FOR THE ANALYSIS OF SATELLITE OBSERVATIONS OF THE GRAVITATIONAL FIELD AND PHYSICAL LIBRATION OF THE MOON

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Introduction: Recently, the number of countries involved in space exploration of the Moon has significantly expanded. The present work is devoted to the development of a software for two-parameter cross-correlation dependence construction in order to describe stochastic similarity manifested in time series of satellite observations of gravity field and lunar physical libration [1, 2]. The software package "Automated stochastic analytical complex" (ASAC) was created [3].

Methods: ASAC is based on the new method of processing and analyzing lunar satellite observations taken over long time periods developed on the basis of modern researches in the fields of non-equilibrium statistical physics and physics of complex systems [4]. This method will allow to analyze the effects of statistical memory, describe the dynamics of short- and long-term correlations and establish Markov and non-Markov features of long-term satellite observations [5]. The software to construct the two-parameter crosscorrelation dependencies for stochastic similarity description, which manifest themselves in time series of satellite observations of the Moon's gravity field and physical libration is going to be developed. The statistical indicators designed to study the dynamic states of the Moon's gravitational field and physical libration will be derived [6].

Results: Computer programs were developed for the reduction of satellite observations. The software modules included in the ASAC allow the solution of overdetermined and normal systems of conditional linear algebraic equations [7]. There is the possibility of using step-by-step regression analysis, which is used to obtain a model with fewer observations [8]. 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 PLL is used [9].

Discussion: The present research assumes the analysis of complex multi-parameter systems, such as heterogeneous satellite observations, physical libration of the Moon, parameters of the lunar gravitational field [10]. To study the dynamic and stochastic features of such systems, as well as to develop statistical indicators for the purpose of parametrizing the time series of satellite observations, it was decided to additionally use modern methods of statistical physics and physics of complex systems. In particular, we are talking about the method of the abbreviated description of multiparameter processes of high dimensionality and the finite-difference generalization of the theoretical-functional technique of Zvanzig-Mori projection operators, adapted for the case of analyzing the dynamics of correlations of discrete systems [11]. Fundamentally new possibilities in extracting information contained in the satellite time series of lunar missions will be demonstrated thanks to the input of two-parameter cross-correlators characterizing the dynamic interconnection - the cross-correlations of simultaneously recorded signals of experimental parameters [12].

Conclusions: As a result of this work, we developed the automated stochastic analytical complex for solution the fundamental problems of selenodesy and space lunar navigation [13]. The work includes development and implementation of a range of advanced physical models, experimental and data analysis methods, software development to solve the tasks of construction high precision space based navigational systems, which have a significant practical importance, as it will be possible to use the project results to create space navigational devices for space exploration in future [14].

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