

THE ANALYSIS OF THE METEOROID DANGER ON THE EARTH-MARS ROUTE

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Introduction: Currently, the exploration of Mars using unmanned spacecrafts is one of the most demanded by the International space agencies tasks. Now there are Mars Science Laboratory (MSL) and “Curiosity” rover [1] intensively working on the surface of the planet. This paper focuses on the determination of meteorite hazard on the Earth-Mars route and the development of the State Standard. This standard GOST is still the best compared to the American (by NASA) and European (by ESA) ones. There is also another standard “Meteor matter. Terms and definitions” [2] co-authored by the researchers of the meteor department of the Engelhardt astronomical observatory (EAO) [3]. Both standards are still binding documents when designing spacecrafts.

Methods: At EAO the works on the study of genetic connections between NEOs are being carried out [4]. The complexity of analyzing the meteor hazard is that observations of meteors taken on the Earth’s surface could not provide the complete description of the meteorite environment at all parts of the Earth-Mars route: the closer to Mars, the less meteor orbits with the same elements cross the Earth’s orbit and parts of spacecrafts’ trajectory. The data on ground-based observations had therefore to be extrapolate [5]. Besides, the results of observations of meteors taken during the Mariner-2, Mariner-4, Pioneer-10, Pioneer-11, Mars Atmosphere and Volatile Evolution (MAVEN), Phoenix, Trace Gas Orbiter missions were used. The data on zodiacal light was involved as well. The derived formula for the transformation of sporadic meteor flow’s density from one coordinate system to another allowed to reprocess the results of observations of meteors produced by the Mariner-4 and Pioneer-10 spacecrafts.

Results: According to the data provided by 3 sensors installed on the spacecraft travelling from the Earth’s orbit to that of Mars, there is a twofold exponential increase in sporadic meteors flux density for bodies heavier than 10^{-6} g and sixfold increase for meteoroids in the mass range from 10^{-12} to 10^{-6} g. Beyond the orbit of Mars there is a sharp drop in flux density down to the normal level. This led to the conclusion that the surfaces of Mars and its 2 moons – Phobos and Deimos – are sources of secondary ejection of meteor bodies at their bombardment by meteorites from the main asteroid belt. This hypothesis was also confirmed by theoretical studies conducted at Saint Petersburg State University.

Discussion: At the analysis of geopotential height in the northern hemisphere the hypothesis of the existence of geostrophic winds was confirmed [6]. The circumterrestrial space including lower atmosphere, mesosphere, lower thermosphere, and ionosphere, was investigated using the radar methods; the parameters describing the influence of lower and middle atmosphere on wave propagation were determined [7].

Conclusions: It should be noted there was also another scientific program, in which the team of the EAO meteor department took part, called the Global Meteor Observations System (GLOBMET). The program was aimed at the analysis of radio and optical observations of meteor showers [8] and at the development of the physical principles of their interaction with the Earth’s atmosphere. There are special methods of analyzing meteorological processes at the mesopause region of atmosphere [9]. It is well known that tidal temperatures strongly affect the predicted motion of geostrophic winds [10], and the determination of height characteristics is a complex problem [11]. The development of methods for accounting those processes is therefore a relevant task [12].

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