PRE-ATMOSPHERIC SIZES AND ORBITS OF SEVERAL CHONDRITES;

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Introduction: Pre-atmospheric sizes and masses of meteorites are important factors of their evolution. However, fallen and, especially, collected meteorite masses considerably differ from the pre-atmospheric masses due to strong ablation in the Earth atmosphere. Meanwhile, the knowledge of pre-atmospheric sizes of meteorites is very important for the study of their radiation history. Due to collisions in space, meteorites are disintegrated, and this changes the geometry of their exposure to cosmic rays. The overlapping of two and more stages of the exposure leads to the situation when samples of the same meteorite can contain different quantities of cosmogenic radionuclides used in the chronology. As a result, such samples of the same meteorite show different radiation ages, confirming a complicated history of the exposure of this meteorite. Just those cosmogenic radionuclides with different half-lives make it possible to preliminarily trace the changes of meteorite size until its collision with the Earth and, therefore, to reveal a true history of the meteorite [1]. Owing to the analytical method [2] of modeling nuclear reactions in cosmic bodies of different sizes and compositions under irradiation of solar and galactic cosmic rays, the regularities of depth distributions of various cosmogenic radionuclides with different half-lives in meteorites of different chemical groups have been derived. Using such regularities, ten independent methods were developed for the determination of the pre-atmospheric sizes of various meteorites [1,3].

On the other hand, the problem of origin and evolution of meteorites cannot be solved without knowledge of their orbits. Indeed, just the orbits that can define the belonging of meteorites to some family of cosmic bodies, among which, first of all, the sources of meteorites (their parent bodies) should be looked for [1-2]. At present, however, only orbits of the following four chondrites: Pribram, Lost City, Innisfree, and Peekskill are well-known. Meantime, an original method of estimating the aphelion position of chondrite orbits, which uses the difference of ^{26}Al contents in the chondrites mentioned above, has been elaborated [1-2]. The use of this method allowed us to determine the extent of orbits of 102 H-chondrites and 120 L-chondrites [1]. The obtained distributions of the chondrites, depending on the aphelia of their orbits, show that the aphelia of the majority of the chondrites (~75%) are concentrated in the area of 2-2.5 AU from the Sun.

Pre-atmospheric sizes and orbits of 12 chondrites: The developed methods of modeling, based on the regularities of depth distributions of cosmogenic radionuclides in cosmic bodies of different sizes and compositions [1-3], are used to estimate the pre-atmospheric sizes and the extent of orbits of 12 chondrites fallen to Earth in 1967-2000. The experimental data of [4-11] on the contents of radionuclides (^{54}Mn, ^{22}Na, ^{26}Al, ^{60}Co, etc.) in the chondrites are used. The density of tracks of heavy nuclei in the chondrites (where available) are also used to correct the shielding depth of the samples under the surface. The results are presented in the table below.

Discussion: The obtained data on the pre-atmospheric sizes confirm the observable statistics that the pre-atmospheric sizes of fallen (to Earth) and identified chondrites make average ~10-40 cm. This range is in accordance with estimates of the chondrite ablation degree on the basis of analytical dependence of track production rates *(ρ / t)* on screening in ordinary chondrites [12]: the pre-atmospheric masses of 95% of the chondrites are found to be in the interval of 2-3500 kg, which corresponds to the average pre-atmospheric radii of 5-60 cm.

The extents of orbits are in agreement with the conclusion made by us earlier and stated above, that the aphelia of majority of orbits of ordinary chondrites lie in the range of q ' ~ 2 – 2.5 a.e., i.e. near the internal boundary of the asteroidal belt. They are the last links in the chain of the hierarchy of collisions of cosmic bodies. The closest precursors of the ordinary chondrites, their most probable parent bodies, are asteroids of Apollo and Amore families, first of all - 3103 1982 BB, 3752 Camillo, and 3988 1986 LA [1]. As shown in the paper [1], the very initial parent bodies of H- and L-chondrites (7-8 large S(IV) asteroids of the main belt) were different in their structure, so that the mechanisms of the formation of both the groups of ordinary chondrites were different too. It is remarkable in this connection that, in spite of all differences and specific features of parent bodies and mechanisms of the formation of H- and L-chondrites, practically a similar distribution of their orbits, and, respectively, the similar statistics of the falls of ordinary chondrites of both the groups to the Earth are observed. This should become a criterion for a correct modeling process of their formation.

The data submitted in the table are the major parameters of chondrites as natural detectors of cosmic rays in the Solar system. They have been used for calculation of gradients of galactic cosmic rays along the orbits of the chondrites before their fall to Earth in different phases of solar activity, which has allowed us to define the laws of distribution and variations of galactic cosmic rays in the three-dimensional heliosphere [2,13,14].

Table. Pre-atmospheric sizes and orbits of chondrites ((R – pre-atmospheric radius; d-shielding depth of a sample; q ' – aphelion of orbit; r - average heliocentric distance of orbit):

Chondrite		Date of Fall	R, cm	d, cm	Q ', AU.	r, AU.
Denver L6	[4]	15.07.67	≤ 10	≤ 5	2,10	1,72
Malakal L5	[4]	15.08.70	20-30	~ 20	3,72	2,88
Kabo H4	[4]	25.04.71	16-20	2-5	2,60	2,08
Guibga L5	[4]	26.02.72	~ 20	~ 5	2,10	1,77
Jilin H5	[4]	08.03.76	~ 85	10-40	2,17	1,78
Kutais H	[5]	28.11.77	20-30	~ 15	1,98	1,65
Gujargaon H5	[6]	04.09.82	~ 10	~ 10	≤ 1,9	1,57
Tomiya H5	[7]	22.08.84	30-40	~ 20	2,09	1,71
Binningup H5	[8]	30.09.84	20-30	~ 20	1,81	1,48
Kokubunji L6	[9]	29.07.86	~ 25	7-8	1,93	1,61
Trebbin LL6	[10]	01.03.88	20-30	~ 20	1,97	1,88
Coleman L6	[11]	20.10.94	30-40	~ 15	3,12	2,62

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