RELATIVE ABUNDANCE OF THE SUPER-HEAVY (Z>50) GALACTIC COMIC RAY NUCLEI: NEW RESULTS OF THE TRACK INVESTIGATIONS IN THE PALLASITE MARJALAHTI OLIVINE CRYSTALS. L.L. Kashkarov[1], A.V. Bagulya[2], M.S. Vladimirov[2], L.A. Goncharova[2], A.I. Ivliev[1], G.V. Kalinina[1], N.S. Konovalova[2], N.M. Okateva[2], N.G. Polukhina[2], A.S. Roussetski[2], N.I. Starkov[2].
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Introduction: In the experimental investigations, realized within the framework of the OLYMPIA project [1], basic positions of the charge identification methodology for nuclei of the super-heavy galactic cosmic ray (GCR) are considered. For this purpose geometry and dynamical track parameters of the not-annealed traces of the stalling nuclei in the olivine crystals from the Marjalahti pallasite are used. The preliminary results of the nuclei-charge determination, obtained by us were presented in [2-5].

Method of the nuclei charge identification. The etched during certain time-interval track length (L) and the etching rate (V_{TR}) along of the base track zone in the not-annealed olivine crystals from the Marjalahti pallasite are measured. The chosen methodology [6] is based on precise measurements of these track parameters in the course of the step-by-step chemical etching of the olivine crystals. Parameters of individual tracks are traced and recorded by using of a modern, high-precision, completely automated measuring system PAVICOM [7]. Samples of the revealed syringe-shape tracks are shown in Fig.1. Recognizing, that the chemically etched zone of the crystal structure disordering, lies in an interval of the nucleus energy E_{MAX}-E_{MIN}, in which the specific losses of energy $(dE/dx)_{el}$ exceed the critical value of 18±2 MeV/mg·cm^{-2} [8]. As a first approximation the V_{TR} depends on specific density of ionization (J): $V_{TR} \approx C \times J^n$, where C is a constant and $n \approx (5 \div 6)$ [9]. For the calibration of these parameters the olivine crystals from Marjalahti pallasite were exposed on UNILAC accelerator in Durmstadt, Germany with Xe and U beams. Within the limits of measurement errors determined track-lengths coincides with the values accounted by the SRIM-2006 [10] and GEANT-4 [11] programs. TheV_{TR} values for these nuclei of Emax=11.4 MeV/nucleon lies in interval of (5÷20) µm/hour, correspondingly. The last have been carried out using additionally the data of the Marjalahti pallasite olivine irradiation by the accelerated up to 150 MeV/nucleon energy U nuclei [12].

Results: Detailed analyses of the dynamic and geometry parameters for near 1200 revealed up to this time tracks with etched and registered length L = 50-500 µm in comparison to the data of the calibration experiments have been performed. Relative abundance of the some groups of the GCR super heavy nuclei, identified by the track parameters in the Marjalahti pallasite olivine crystals, are given in Table and Fig.2.

Discussion and conclusion: Received on the given stage of researches the results of identification of a charge spectrum of the super heavy nuclei group (Z>50) of the GCR, based on measurements of the geometrical and dynamic parameters of tracks, chemically etched in the olivine crystals from the Marjalahti pallasite, have shown: (1) From the common number of the registered tracks with the charge Z>50 four of them corresponds to Th-U group nuclei; (2) Ratio of registered in our up to day investigation nuclei with Z>50 to nuclei of iron group (23<Z<28) has made. The relative abundance values equal to ~1.2×10^{-6} and ~6×10^{-7} for the Pt-Pb and Th-U groups correspondingly were determined. Note the used up to day Z-identification method in a majority of cases gives somewhat lowered values in comparison to the true nucleus charge meaning. This discrepancy will be corrected by the special calibration experiments.

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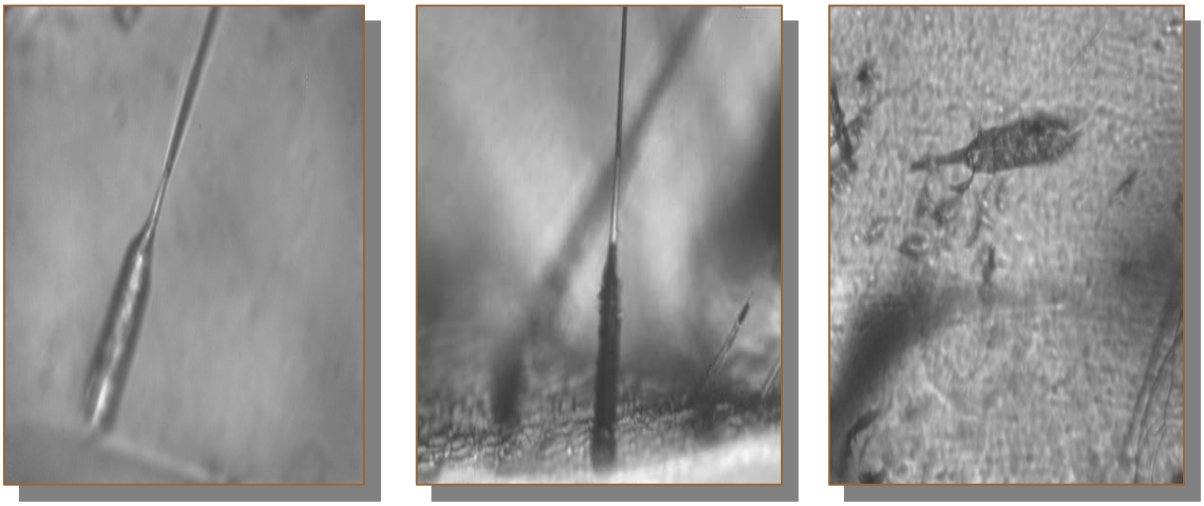

Fig. 1. PAVICOM microphotography's of the long-path syringe-shape tracks of nuclei of the charge Z>50. Tracks are revealed during one etching cycle (48 hour) in the standard conditions in the olivine crystal from the Marjalahti pallasite. The size of each field ~150×200 µm.

Table . Relative abundance of the galactic cosmic ray super heavy nuclei with 56 ≤ Z≤ 92 by the track data in the olivine crystals from the Marjalahti pallasite.

Charge group	Number of tracks, N_Z (*)	L, µm (**)	Track density, cm^{-3}	Relative abundance
23 ≤ Z ≤ 28	~3000	3-14	(1 - 5) × 109	1
56 ≤ Z ≤59	133	100-150	6.0× 104	2× 10-5
60 ≤ Z ≤ 69	282	150-300	1.3× 105	4.3× 10-5
70 ≤ Z ≤ 79	146	300-500	6.6× 104	2.2× 10-5
80 ≤ Z ≤ 89	8	500-700	3.6× 103	1.2× 10-6
90 ≤ Z≤ 92	4	> 800	1.8× 103	6× 10-7

(*) Number of tracks, registered and measured in 27 olivine crystals of the total volume ~2.2 mm^3;
(**) Chemically etched length of tracks, measured during of the (3-4)-times of 48 hour etching period.

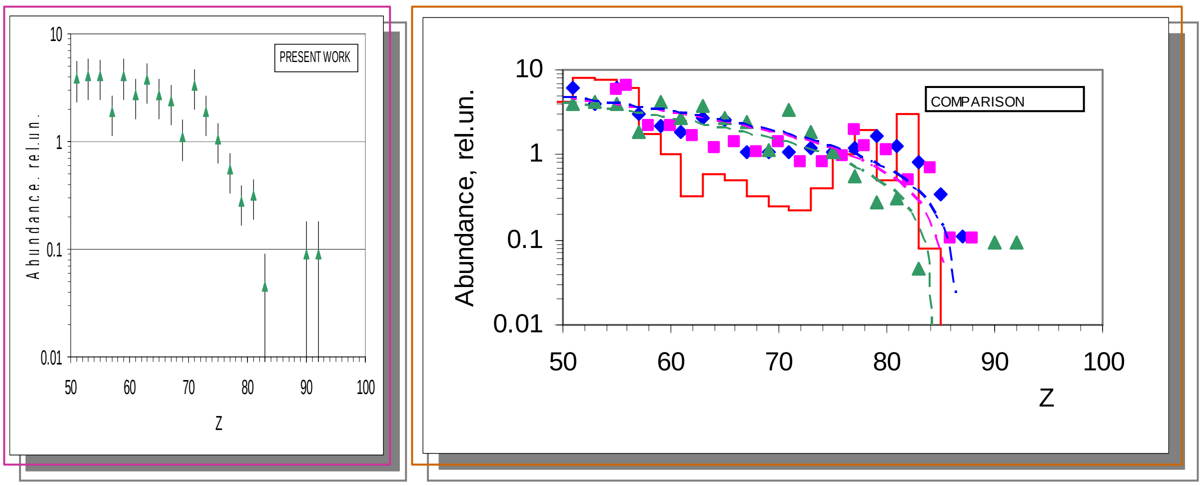

Fig.2. Super-heavy (Z>50) GCR nuclei abundance obtained in present work in comparison with the equipment measuring [13] and [14]. Dashed lines are trends for the indicated three groups of data. Bar graph is distribution on Sun [15].