SUPER-HEAVY (Z>50) GALACTIC COMIC RAY NUCLEI ABUNDANCE ON THE BASE OF THE TRACK PARAMETERS MEASURING IN THE PALLASITE OLIVINE CRYSTALS

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Introduction. In the work realized within the framework of the project OLYMPIA [1], basic positions of the charge determination methodology for the heavy and super heavy galactic cosmic ray (GCR) nuclei are considered. For this purpose chemically etched lengths and track-etch rate of the not- annealed traces of the braking nuclei in the olivine crystals from the Marjalahti pallasite are used. The preliminary experimental results of the nuclei-charge determination, obtained by us were presented in [2].

Method of the nuclei charge determination. In this study the geometry (track-length) and dynamical (track-etch rate) characteristics of chemically etched tracks in the not-annealed olivine crystals from pallasite meteorites are investigated with the aim to identification of galactic cosmic ray heavy and super-heavy nuclei charge. The chosen methodology is based on precise measurements of the nucleus 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 [3] (sumple of tracks are shown in Fig.1). The emphasis is done on measurements of the next main parameters: the etched during certain time-interval track length (L) and the etching rate (V_{TR}) along the different parts of the base zone formation of tracks. Recognizing, that the zone of the crystal structure disordering, corresponding to chemical etching, is in an interval of the nucleus energy E_{MAX} - E_{MIN} , where the specific losses of energy $(dE/dx)_{EL}$ exceed the critical value of 18±2 MeV/mg·cm^{-2} [4], the length of a track with increase of a nuclei charge also increases. As a first approximation the substance etching velocity in the track formation zone (V_{TR}) depends on specific density of ionization (J): $V_{TR} \approx C \times J^{n}$, where C - constant, n ≈ (5÷6) [5]. For the calibration of these parameters the olivine crystals from Marjalahti pallasite were exposed on UNILAC accelerator in Durmstadt, Germany (V.P. Perelygin, 2000) with Xe and U beams. On base of obtained track-length distributions were determined L_{max} (Xe) = 80 ± 5 μm and L_{max} (U) = 85 ± 5 μm. Within the limits of measurement errors these track lengths coincides with the values accounted by the SRIM-2006 [6] and GEANT-4 [7] programs. The track etching velocity (V_{TR}) for the Xe and U nuclei of E_{max} = 11.4 MeV/nucleon varies in limits (5÷20) μm/hour. The last have been carried out using additionally the data of the Marjalahti pallasite olivine irradiation by the accelerated U nuclei of the 150 MeV/nucleon energy [8].

Results. Detailed consideration of the dynamic and geometrical parameters for 853 revealed up to this time tracks with the 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 galactic cosmic ray super heavy nuclei, identified by the track parameters in the Marjalahti pallasite olivine crystals, are given in Table. Note, the determined by used up to day method Z values in a majority of cases gives only somewhat lowered Z-values in comparison to the true nucleus charge meaning, that will be corrected by the special calibration experiments.

Conclusions. 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 galactic cosmic ray, 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 853 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 ~ 1.2× 10^{-6} and ~

6×10^{-7} for the Pt-Pb and Th-U groups correspondly.

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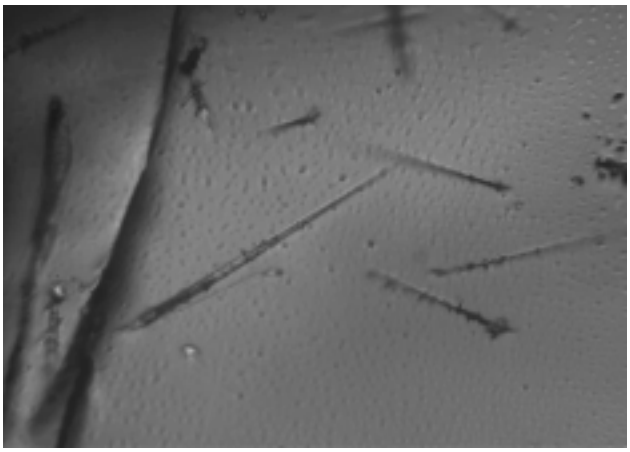

[A]

[B]

Fig. 1. The long-path tracks of nuclei of the charge Z>50, received as a microphotography [A] and a numerical code image [B] on PAVICOM. 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 ~200×250 μm.

Table . Relative abundance of the galactic cosmic ray super heavy nuclei with $56 \le Z \le 92$ 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
$23 \le Z \le 28$	~3000	3-14	$(1 - 5) \times 10^9$	1
$56 \le Z \le 59$	133	100-150	6.0×10^4	2×10^{-5}
$60 \le Z \le 69$	282	150-300	1.3×10^5	4.3×10^{-5}
$70 \le Z \le 79$	146	300-500	6.6×10^4	2.2×10^{-5}
$80 \le Z \le 89$	8	500-700	3.6×10^3	1.2×10^{-6}
$90 \le Z \le 92$	4	> 800	1.8×10^3	6×10^{-7}

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