**DETERMINATION OF THE COSMIC DUST FROM THE ISON COMET IN THE MOSCOW REGION**

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## Abstract

Attention of astronomers from all over the world at 2012-2013 was focused on the comet C/2012 S1 (ISON). It came at a distance of 1.17 million km near the Sun at 28.11.13 and fall to pieces. Snow samples were collected around the Dubna city at the period when Earth came through the comet dust cloud. Melted water fractions with less than1 µm and more than 1 µm particles were analyzed separately. Snow samples contained increased compared with normal for this region content of Os, Ir, Au, Pt, U.

## Introduction

The ISON comet was discovered on 21 September 2012 by Russian astronomers Vitali Nevski and Artyom Novichonok. ISON passed at a distance of 1.17 million kilometers from the Sun's surface on 28.11.13 at 22:30 on Moscow time. With the passage of the perihelion, the comet disintegrated into pieces. According to the calculations of most astronomers [1, 2], the dust cloud with smaller than 10 µm particles resulting from the comet collapse has covered the Earth in the period from 12.01.2014 to 17.01.2014.

The study of the substance of the comet has of great scientific interest. Some scientists believe that comets may be carriers of life in the Universe (the hypothesis of space panspermia). The comet first flew in the inner region of the Solar system from the Oort cloud, so the volatile substances of it ice core have not been disturbed and has not been seriously affected by heat and gravity. The age of the comet was estimated at 4.5 billion years and the study of dust particles from the ISON comet may answer on questions about the substance at the time of formation of our planetary system.

## Experimental

To conduct the study, samples of snow were taken in the vicinity of the Dubna city in the period of Earth passage through the dust cloud of the comet, few days before it and few days after it. Upper layer of snow less than 5 cm was collected and melted. Melted water samples were filtrated through the polymer nuclear filter with pore size 1 µm (F-fraction was stay on the filter). Less than 1 µm particles were co-precipitated with $Fe(OH)_3$ (OH-fraction): 50 $\mu g/dm^3$ $Fe^{3+}$ solution was added and NaOH solution was added dropwise to pH=8. Received precipitates were filtered through the polymer nuclear filter.

Also, evaluation of potential $^{137}Cs$ technogenic pollution of snow samples was conducted. After precipitation with $Fe(OH)_3$ and following filtration, solutions were boiled down to 50 ml and acidified by $HNO_3$ to pH=5 [3]. $^{137}Cs$ was sorbed at the dynamic conditions with the m(sorbent)/V(solution) = $10^{-2}$ g/ml ratio at the granulated $K_2Ni[Fe(CN)_6]$ sorbent.

Solution and precipitate samples were analyzed by nuclear physics methods.

*X-ray fluorescent analysis (XRF).* Multi-element analysis of dried precipitates on filter was conducted by the X-ray fluorescent spectometer at FLNR JINR. Radioisotope $^{109}Cd$

(E=22.16 keV, $T_{1/2}$=453 d) and $^{241}$Am (E=59.6 keV, $T_{1/2}$=458 y) sources were used for excitation of X-ray radiation. Characteristic radiation was registered by a semiconductor Si(Li) detector with 145eV resolution on Fe line (6.4 keV). Element contents at the explored samples were determined by the simultaneous determination method in saturated layer [4].

*Gamma-activation analysis (GAA).* Standards of Au, Ir, Pt, Os, U, Th and dried precipitates on filter, which put on 5 mm high and Ø=35mm polyethylene cassettes covered by 6-10 μm lavsan film, were irradiated 2-5 h by gamma-rays with energy $E\gamma = 24$ MeV on the compact electron accelerator MT-25 microtron at FLNR JINR. Electron current was 15 μA. Methods similar with [5, 6] were used.

*Gamma-spectroscopy.* Natural activity of precipitates on filters and sorbents as well as activity of irradiated samples were measured by Canberra gamma-spectrometer with a HP Ge detector, which has 1.5 keV resolution and 1% efficiency on 1.33 MeV ($^{60}$Co) line. Measurement time was 1-24h.

**Results and discussion**

The content of elements in 1 $dm^3$ of thawed water on the average corresponds to the content of elements in 5 liters of snow collected from a five-centimeter of 0.1 $m^2$ surface layer.

Plenty of elements, such as Mg, K, Ca, Cr, Fe, Ni, Cu, Zn etc., may be contained in cosmic particles [7, 8]. However, for sparse and platinum-group elements (Os, Ir, Au, Pt, U) a difference between their content in cosmic particles and the earth's crust should be more noticeably. It is considered that iridium is a precise indicator of cosmic matter presence in the samples, since its content in meteorites is approximately 20,000 times higher than in rocks of the earth's crust. Therefore, to these components was paid attention.

Contents of macro components were determined by XRF. The XRF spectrum is shown in Fig.1.

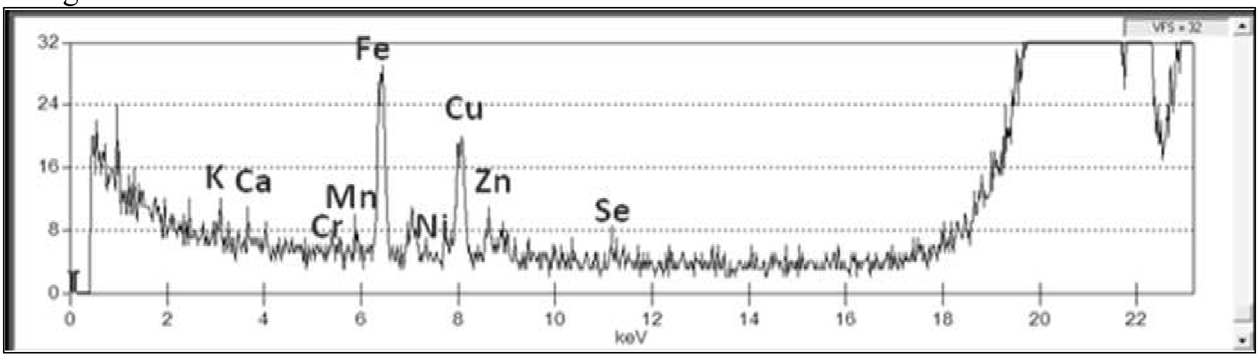


Fig.1. The X-ray spectrum of F-fraction (>1 μm particles on filter) of sample 17.01.14 obtained by $^{109}$Cd source.

Ir, Au, Pt, Os, U and Th were determined by GAA. Nuclear reactions, which interesting to this research, are shown in the Table 1.

The spectrum of irradiated OH-fraction of sample 17.01.2014 was shown in Fig. 2. Visible content differences of Fe, Ni, Cu, Cr, Zn, Th, Pt in various samples not found. However, elevated contents compared to usual levels of elements such as Ir, Os, Au, U were found in the snow samples in the period of the Earth passage through the dust cloud.

Table 1. Reactions of interest to this research for GAA

| El | Isotope | $T_{1/2}$ | Eγ, KeV (%) | Reaction |
|---|---|---|---|---|
| Ir | Ir-190 | 11.8d | 605 (41.3), 187(53.4) | $^{191}Ir(\gamma,n)^{190}$ Ir |
| Au | Au-196 | 6.2d | 333 (23), 355.7 (86.9) | $^{197}Au(\gamma,n)^{196}Au$ |
| Pt | Pt-197 | 18.3h | 77 (17.1) | $^{198}Pt(\gamma,n)^{197}Pt$ |
| Os | Os-183 | 13h | 114.59 (20), 381.7 (89.6) | $^{184}Os(\gamma,n)$ $^{183}Os$ |
| U | U-237 | 6.75d | 208 (21.14) | $^{238}U(\gamma,n)^{237}U$ |
| Th | Th-231 | 25.5h | 25.65 (14.6), 84 (6.65) | $^{232}Th$ (γ, n) $^{231}Th$ |

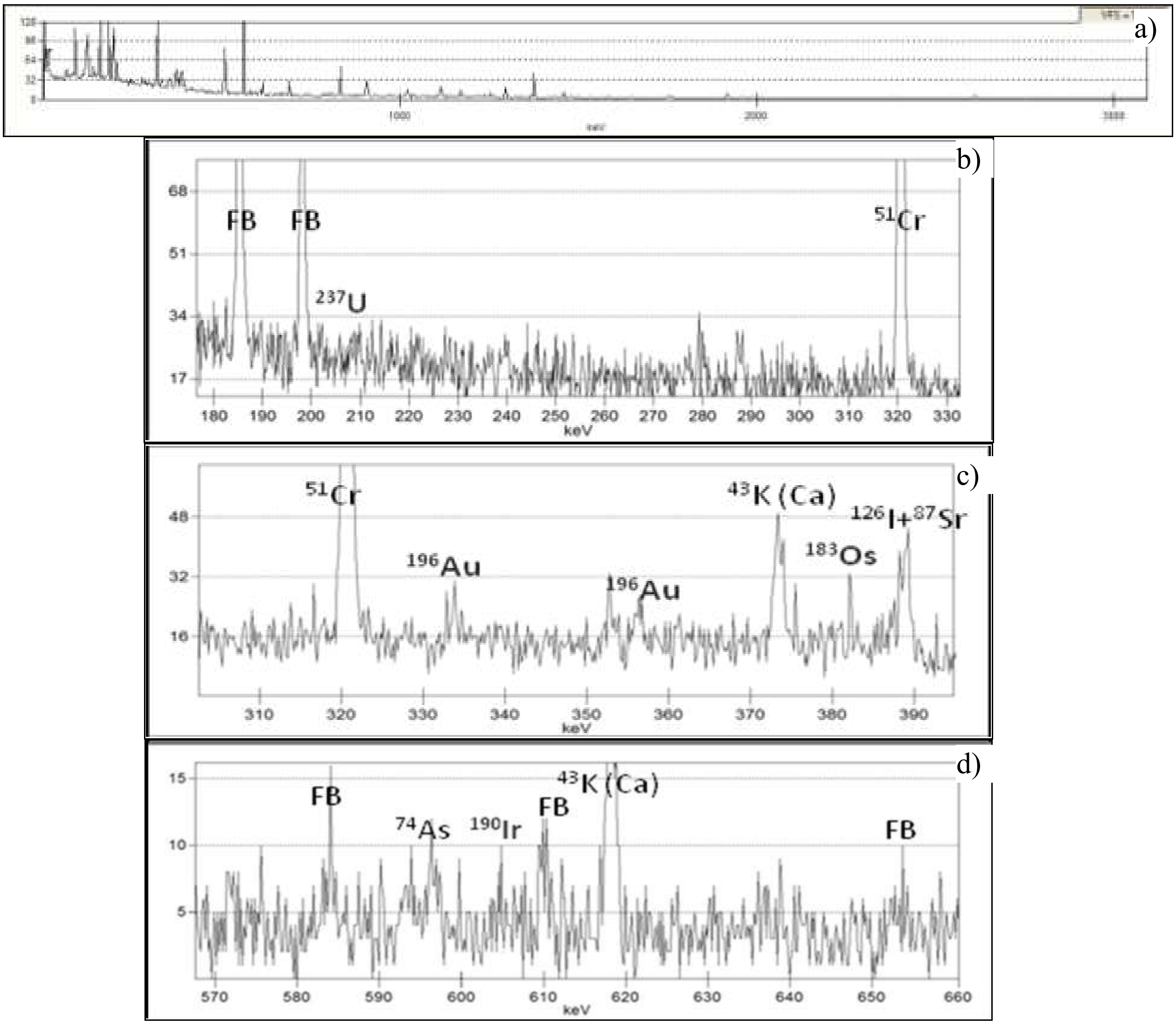


Fig.2. The spectrum of irradiated OH-fraction of sample 17.01.2014 (a) and fragments of spectrum (b), (c), (d). Filter background (FB) peaks concern to irradiated filter without a sample.

The change of Ir, Os, Au and U content in melted water samples in the period of the Earth passage through the dust cloud is shown at the Fig.3. White bars correspond with a more than 1 μm particle size fraction (F-fraction) and grey bars correspond with a less than 1 μm particle size fraction (OH-fraction).

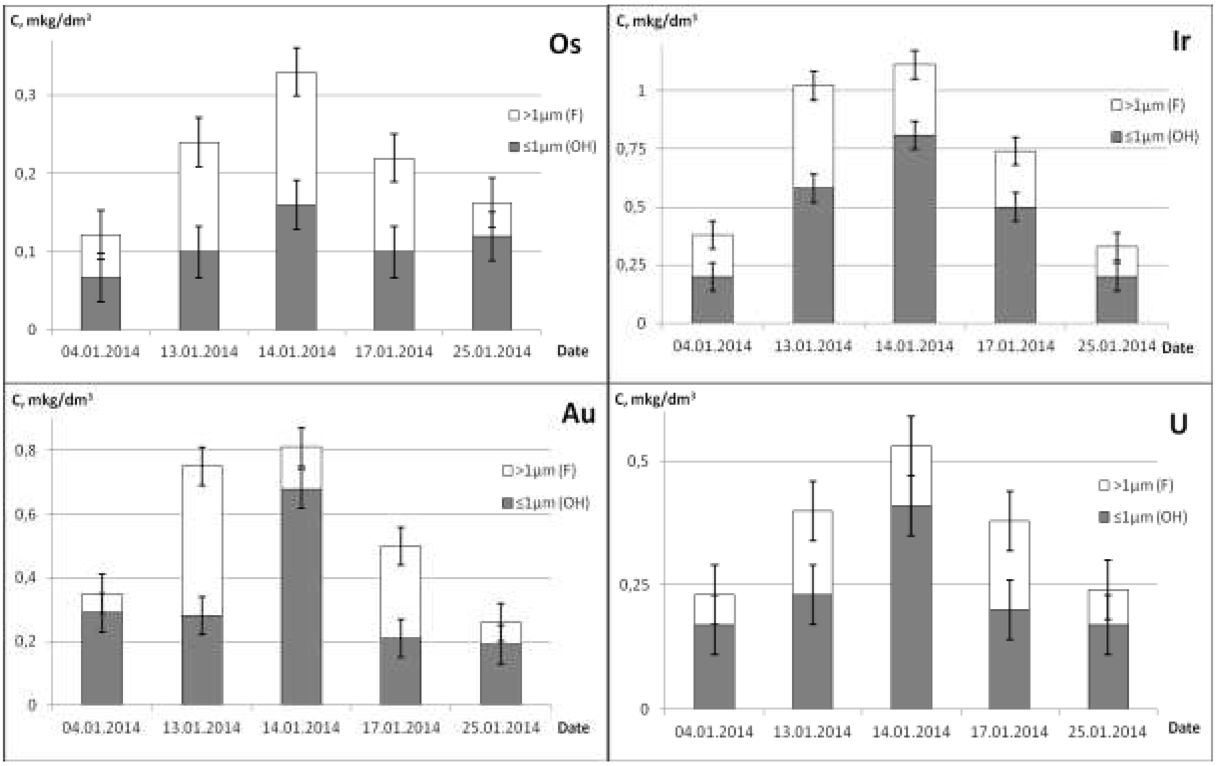


Fig.3. The change of Ir, Os, Au and U content in melted water samples in the period of the Earth passage through the dust cloud. White bars correspond with a more than 1 μm particle size fraction (F-fraction) and grey bars correspond with a less than 1 μm particle size fraction (OH-fraction).

Determination of $^{137}Cs$ was conducted for evaluation of the environmental state. A content of radio-Cs was less than 0.0049 $Bq/dm^3$ in all samples. Accordingly an obtained result indicates on unpolluted region by cesium.

**Conclusion**

Elevated compared to usual levels of Ir, Os, Au and U in the snow samples from Moscow region at the period of the Earth passage through the cosmic dust cloud was determined. Obtained results indicates the possibility of a comet observation by snow cover samples (and dust samples) research at Moscow region.

**Acknowledgements**

The authors are grateful for the help in the work to Semina V.K., Levkovich N.V., Voronyuk M.G.

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