SEARCH AND IDENTIFICATION OF EXTRATERRESTRIAL PARTICLES (MICROMETEORITES)

Anastasiya Martynava[1], Anastasiya Huryna[1], Natallja Arekhava[1],
Anatoli Zajogin[2], Maksim Shundalau[2]

[1] Secondary School No. 64, Minsk, Belarus
[2] Faculty of Physics, Belarusian State University, Minsk, Belarus
nastzmart2002@mail.ru

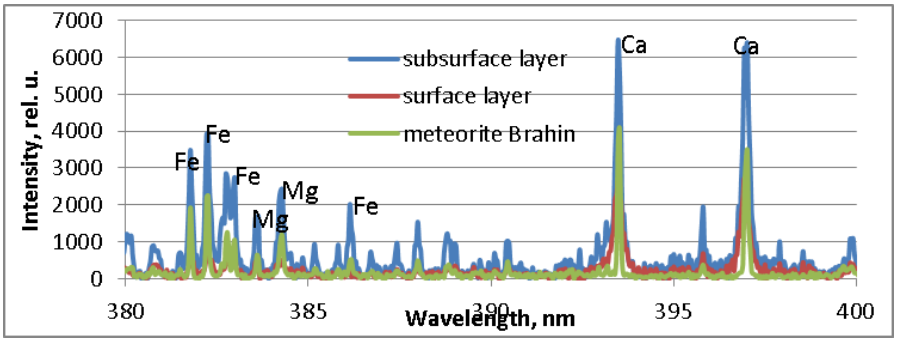
Micrometeorites are small (usually < 0.5 mm) extraterrestrial particles of dust that have mainly asteroid and comet origin. It is estimated that approximately 7 tons of extraterrestrial dust daily reach the Earth surface [1]. In contrast of rare large meteorites, micrometeorites fall to the Earth daily and accumulate on its surface. They can be found on flat roofs in the warm dry season. Micrometeorites contain important information of state of interplanetary matter and its evolution. The classification of micrometeorites one can find in [2].

In this study, at the first time in Belarus micrometeorites were found and their chemical composition was established by laser-induced breakdown spectroscopy.

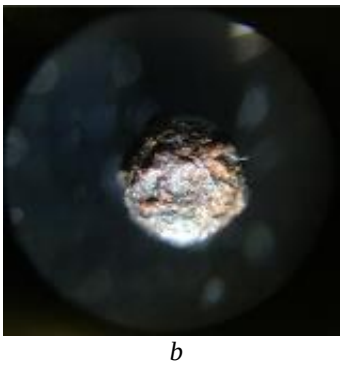
Firstly we have collected dust from the part (10×5 m) of the roof of apartment building by mobile electric vacuum cleaner before and after Earth's passing through Arietids, Southern Delta Aquariids, and Perseids meteor showers. Then we have sifted samples and separated small particles from large ones. After that light particles were removed by flushing out with water and sediment has been dried. Particles with magnetic properties have been separated by a magnet. Then we viewed them through the Delta Optical BioLight 300 microscope (up to 400× power) and took samples, which are similar to spherules, particles with unusual structure and color and particles looking as melted. Using Larsen's classification [3] we have pre-selected samples of terrestrial origin and extraterrestrial particles supposed. All of them were from 0,3 to 3 mm.

The chemical composition of 82 particles was determined using double-pulse atomic-emission spectrometry. The analysis has been carried out using multichannel laser LSS-1 spectrometer, which has the following characteristics: wavelength is 1064 nm (first harmonic of Nd:YAG laser), pulse duration is around 15 ns, pulse energy is 35 mJ, pulse-to-pulse time interval is 8 μs. The thickness of the layer evaporating by laser ablation is 5 μm, which makes it possible to perform a layer-by-layer analysis of the largest particles.

The spectra of the iron and stony parts of the Brahin meteorite (pallasite) [4] were used as reference spectra. Fig. 1*a* presents emission spectra of the iron part of Brahin meteorite and one of the samples (surface and subsurface layers). One can see that this particle has the similar chemical composition as the iron part of Brahin pallasite. The presence of such elements as iron, magnesium, calcium, and titanium (the only one particle) has been established in the collected samples. Totally, 19 iron micrometeorites have been identified by laser spectral analysis. One of the iron meteorites is shown in Fig. 1*b*.



a



b

Fig. 1. Emission spectra of iron part of Brahin meteorite and one of the iron micrometeorites (*a*). Microscope image of one of the iron micrometeorites (*b*).

Similar studies were carried out for stony samples (one chondrite including). Using layer-by-layer analysis of the particles collected after passing of the Perseids shower it is determined that the samples contain magnesium only in internal layers. This fact indicates an extraterrestrial origin of the particles, because magnesium was evaporated from surface when micrometeorites passed through the Earth's atmosphere. Totally, 7 stony micrometeorites have been found using laser spectral analysis.

[1] S. Taylor, J.H. Lever, R.P. Harvey. Accretion rate of cosmic spherules measured at the South Pole. Nature 392, 899 (1998).
[2] M.J. Genge, C. Engrand, M. Gounelle, S. Taylor. The classification of micrometeorites. Meteorit. Planet. Sci. 43, 497 (2008).
[3] J. Larsen. In Search of Stardust: Amazing Micrometeorites and Their Terrestrial Imposters, Voyageur Press, 2017.
[4] The Meteoritical Society. Database. Meteorite Brahin. https://www.lpi.usra.edu/meteor/metbull.php?code=5130