

PROGRAM OF SPACE EXPERIMENTS OF LOMONOSOV MOSCOW STATE UNIVERSITY: 2005 – 2015

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The program of scientific and educational satellites for research of various processes in the atmosphere, near-Earth space and outside of our galaxy is developed and successfully implemented in Lomonosov Moscow State University. This program allows to involve students and young scientists into the space experiments.

The program was started with the launch of two satellites: “Universitetsky-Tatiana” [1] in 2005 and “Universitetsky-Tatiana-2” [2] in 2009. The main objectives of the experimental research of these satellites were to study the effects of solar and geomagnetic activity on the radiation in the magnetosphere, as well as the study of the transient luminous events (TLE) in the Earth's upper atmosphere. The scientific payload of Tatiana-1 satellite consists of six detector modules: BD1-BD4 (semiconductor, scintillation and gas discharge detectors of charged particles), DUV (UV radiation detector), EA (electrostatic analyzer) and information block. Tatiana-2 scientific equipment contains UV and IR detector, charged particles detector and MTEL (telescope for TLE based on micro-electro-mechanical (MEMS) optics technology). One of the most significant results of these satellites studies is a measurement of a large number of UV flashes occurring in the Earth's atmosphere. The geographical distribution of these flashes is obtained. The bright events coincide with the distribution of global storm areas, but dim ones have more even distribution. Unusual events taking place not above the cloud cover and the distance (1,000 km) from lightning areas are detected [3]. These unusual results need to be confirmed in other experiments and further investigation.

July 8, 2014 was successfully launched into orbit a new satellite “RELEC” [4]. Scientific equipment “RELEC” is intended to study the precipitation of relativistic electrons from the radiation belts, their impact on the atmosphere and ionosphere, study the response of the atmosphere to the precipitation of relativistic electrons, including the observation of TLE. The structure of scientific equipment includes the following detector units:

- 1) DRGE – detector of X-ray and gamma radiation from atmospheric phenomena in the energy range from 0.01 to 3.0 MeV and electrons in the energy range from 0.3 to 10.0 MeV.
- 2) DUF – detector UV radiation. Provides registration UV radiation from the atmosphere and TLE in the range of wavelength from 300 to 400 nm.
- 3) Telescope-T. Provides images of TLE in optical and UV ranges.
- 4) RChA-NCha - low frequency and radio frequency electromagnetic radiation analyzer.

During the flight tests, it was shown that all the scientific equipment operates normally, and the first scientific data from all devices were obtained.

The new satellite Lomonosov is planned to be launched in 2015. A set of instruments for the study of various extreme processes in the Earth's atmosphere and in deep space will be installed on board. Scientific objectives of the mission include: detection of cosmic gamma-ray bursts in the optical and gamma wavelength ranges, measurements of ultra high energy cosmic rays (above the Greisen-Zatsepin-Kuzmin cut-off: $5 \cdot 10^{19}$ eV), the study of TLE in the Earth's upper atmosphere and measurements of charged particles of the magnetosphere. Payload consists of the following detectors:

- 1) Ultra high energy cosmic rays detector TUS, which consists of a large mirror-concentrator (2 m²) and photo detector with 256 pixel (photo multiplier tubes) on the focal plane. The detector measures fluorescent tracks of extensive air showers generated by high-energy particles.
- 2) The complex of gamma-ray bursts (GRB) detectors: BDRG (the device is designed to monitor and localization of gamma-ray sources on the celestial sphere in the gamma

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range, as well as for generating trigger signals for optical cameras), ShOK (Wide aperture optical camera composed of two fast wide-angle cameras, whose field of view is in the detection area other tools for GRB, located on board the satellite "Lomonosov"), UFFO - UV and Optical Telescope and X-ray camera.

- 3) ELFIN-L – joint development of the Institute of Geophysics and Planetary Physics, University of California, Los-Angeles (UCLA) and SINP, consists of magnetometer and detectors of energetic protons.
- 4) IMISS-1 – device for testing the quality of functioning of MEMS inertial measurement units in the space environment

Scientific payload of Lomonosov satellite is installed to the spacecraft and is being tested now.

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