RESEARCH OF THE EARTH'S UPPER ATMOSPHERE BY THE OPTICAL AND MILLIMETER-WAVE TECHNIQUE («Inframon» project)

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Introduction. The project deals with continuous and long-term monitoring of the events occurring on the Earth's surface, in the atmosphere and in the near-Earth space. The apparatus proposed by the authors can be incorporated into a common measuring complex allowing research to be completed simultaneously in the high-frequency range of the electromagnetic wave spectrum. Moreover, an integrated method of the passive control (without any influence on the studied object) is used, namely the radiometry of thermal radiation.

«BIT» Experiment
ON-BOARD INFRARED TELESCOPE

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The principal idea of the «BIT» experiment is to determine the temperature distribution over the field of view with the spatial and temperature resolution that is good enough to localise the sources of any toxic or harmful outbursts (such as smokes and hot gases), and to study their vertical distribution and global migration. Taking into consideration the absence of precise stabilisation of the ISS, the instrumentation of the on-Board Infrared Telescope (BIT) is based on a highly sensitive matrix image sensor that, in contrast to any scanner, is able to produce an image with a short enough exposition to avoid the blurring caused by space instability of the ISS. Both the temperature and the emission distribution within the field of view can be calculated, if a possibility is provided to compare two images obtained almost simultaneously in the different spectral ranges.

The main objective is to monitor the terrestrial atmosphere and near space. The monitoring should be carried out with a set of instrumentation attached to an on-board infrared telescope for imaging in one or more spectral bands in the range from 1 to 5 μm. The experiment is oriented to the problems of ecology and investigation of the Earth's atmosphere, in order to detect the effects of industrial and natural factors on the environment and climate.

On-board infrared telescope consists of the following units:

— Full steering platform for pointing the telescope onto the object.

— Two mirror telescopes with an aperture of at least 300 mm.

— Beam splitter to divide the input radiation flux between the visible and infrared cameras.

— TV monitor.

— Interface device to link the telescope to the on-board computer.

The Special Research and Development Bureau for Cryogenic Technologies (SR&DBCT) of the ILTPE of the NASU has experience in development of an on-board infrared telescope and highly sensitive infrared sensors, as well as cryogenic equipment. A brass board model of a cryogenic on-board infrared telescope was made in 1980s. It is important to note that SR&DBCT ILTPE possesses all the necessary equipment and technology to test such an instrumentation including outer space conditions simulators. This Research and Development Bureau is the principal manufacturer of the experimental sample of the telescope.

Three operational modes are envisaged:

— the passive mode, when the optical axis of the telescope is permanently directed to the chosen point, e. g. to the limb of the Earth, and images are obtained by a pre-set program;

— the automatic mode, when a sequential pointing program to a programmed list of co-ordinates is running;

— the manual control mode, when the cosmonaut points the telescope manually.

Since the ISS is to be visited by astronauts time after time, there is a possibility to repair the telescope and prolong its cryogenic resource. Therefore, the duration of the experiment is limited only by the lifetime of the ISS itself.

The team that has set up the experiment will own the raw experimental data. The raw data, i. e., the brightness distribution in different parts of the spectrum, need rather complicated professional processing to derive the final results such as detection of the sources of ecological damage, as well as some geophysical information, where the data on global climate phenomena are of a great importance. The final result includes the co-ordinates of the sources of ecological damage together with quantitative estimates of this damage parameters. The potential users of these data are as follows: meteorology, ecological services, the industries that create environmental pollution, and all the authorities concerned.

The project is open to any international co-operation. At present, co-operation with the Russian manufacturers of infrared image sensors has been arranged.

«Climate» Experiment
INFRARED MONITORING OF THE EARTH'S ATMOSPHERE

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Study of the influence of anthropogenic activity of humanity and natural harmful factors on the Earth's atmosphere is an urgent task to understand the causes of variations of the ozone layer, and to construct a model of the thermal state of the atmosphere, as well as to evaluate the water resources in the atmosphere.

The main purpose of the experiment is to monitor gaseous and aerosol pollution of the Earth's atmosphere and their vertical structure and temperature distribution. To accomplish this, we intend to use the absorption spectra of the Earth's atmosphere in the thermal region of the spectrum and spectral polarimetric properties of backscattered light in the spectral range of 200 — 350 nm. The data on the intensity of absorption bands of about 20 gaseous components of the Earth's atmosphere, as well as the parameters of polarization properties and particle size distribution of stratospheric aerosol at the altitudes over 30 km will be obtained.

To meet these goals, we propose placing two observation complexes onboard the ISS. The first one is intended to monitor the composition of the Earth's atmosphere on the global scale and the aerosol physical properties at the altitudes over 30 km. It consists of two Fourier-spectrometers