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

($\lambda = 1 - 5\ \mu$m; $\lambda = 4 - 11\ \mu$m) with the spectral resolution of about 2 cm^{-2} and 1:1 illumination, and a spectropolarimeter ($\lambda = 200 - 400$ nm) with the spectral resolution of about 5 nm. This complex is designed to measure the heat spectrum of Earth and solar radiation reflected diffusely by the Earth's atmosphere. The second complex consists also of two Fourier-spectrometers with the same parameters but with illumination of about (1/10)—(1/20). It will be used for study of vertical distributions of temperature, molecule concentration of various gases and aerosols, as well as of their day-night variation. The solar and lunar radiation against the Earth's atmosphere will be observed with the step of 1 — 2 km at different attitudes above the Earth's limb.

Observations should be carried out one or two times per month on round-the-clock basis in the automated mode to reveal the seasonal and 24-hourly effects.

The results will be used to model the heat regime of the atmosphere and to establish the causes of the ozonosphere variations, to construct the maps of ecological state of various regions of Earth and to estimate the water resources, etc.

«Vertical» Experiment

SPACE-BORNE MILLIMETRE-WAVE NADIR OZONE SOUNDER (SMNOS)

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The principal method to study the atmospheric composition is the molecular spectroscopy of constituent gases. The majority of intense rotational transitions of these gases fall into the millimetre and sub-millimetre wave bands [1].

The purpose of the experiment is to develop a space-borne millimetre-wave spectral complex (SMNOS) for monitoring the global distribution of the total content of the atmospheric ozone. A characteristic feature of the SMNOS complex is its capability to monitor the atmospheric ozone distribution from a satellite orbit not along the line tangent to the atmosphere but vertically down (in the nadir direction). Such an approach eliminated the need for a large antenna system, which would have to meet a number of strict requirements to the design of the complex.

The sounder input is a scalar horn antenna with the diameter of 10 cm. The stable local oscillator will operate near the frequency of 142 GHz with the output power of 10 mW and the frequency stability of 10^{-7}. The uncooled balanced diode mixer with beam leads combines RF signal from the antenna and LO signal to give IF signal at the frequency of 1.5 GHz. The loss by insertion is about 6.1—6.6 dB. The gain of the uncooled low-noise IF amplifier is equal to 60 dB and its noise temperature is 50 K. The noise temperature of this heterodyne down converter is equal to 700 K (DSB). The complex is connected with the recording device, which is capable of operating in a wide frequency range (bandwidth of 500 MHz), as well as in the multi-channel filter-bank mode (10 channels, each with 100 kHz bandwidth). The difference of optical thickness in the spectral channels and the wide-band (reference) channel is used to detect the spectral ozone line against the background of the ascending thermal radiation from the Earth's surface and the atmosphere.

The complex operation is carried out by periodical calibration of its sensitivity against two blackbody radiators (300 K and 100 K). The entire SMNOS complex is thermostated with the accuracy of 1 K. The on-board computer will control its operation.

Analysis shows that the sensitivity of the SMNOS complex can be sufficient for detection of the ozone contained in the atmosphere at the level of 10^{15} mol·cm^{-2}. This is two orders of magnitude lower than the average level of the full ozone content in the Earth's atmosphere.

Reference

1. A Parrish «Millimeter-wave Environment Remote Sensing of Earth's Atmosphere» // Microwave J.—1992.—**35**, N 12.—P. 24—57.