MICRO-SATELLITE "CHIBIS" - UNIVERSAL PLATFORM FOR DEVELOPMENT OF METHODS OF SPACE MONITORING OF POTENTIALLY DANGEROUS AND CATASTROPHIC PHENOMENA

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ABSTRACT

The program of scientific studies on the micro-satellite "Chibis" - "Basic research of the methods of the space monitoring of potentially dangerous and catastrophic phenomena with the use of micro-satellite technologies" - is a subprogram in the Program of basic research of the Presidium of Russian Academy of Sciences "Changes in the environment and climate, natural catastrophes". Space monitoring offers great possibilities for the detection and estimations of potentially dangerous and catastrophic phenomena on the Earth's surface, in the atmosphere, traced to the ionosphere and to the magnetosphere. Some problems, such as, for example, detection of forest fires are already successfully solved with the aid of the space means. On the basis of tasks named above the model composition of the useful scientific payload of the developed "Chibis" spacecraft is determined in the Space Research Institute of RAS, which includes: 1. Magnetic-wave complex (MWC). 2. Complex of atmospheric studies (CAS). 3. Complex of photometric equipment (CPE). The details of this spacecraft are presented.

1. ORIENTATION AND STABILIZATION SYSTEM

The most extended in comparison with first, developed in IKI RAN micro-satellite “Kolibri-2000” [1], is the payload of new micro-satellite "Chibis", whose development begun in IKI RAN with the participation of international cooperation. For the implementation of scientific program the composition and the parameters of all service and support systems of the "Chibis" micro-satellite (MS) is determined. At the stage of the preliminary design special attention is given to questions of the synthesis of the orientation system and the stabilization, which makes it possible to track the selected on the earth's surface coordinates.

The ”Chibis” orientation and stabilization system consists of:

1. reaction wheel - 4
2. fibre optic gyroscope - 3
3. electromagnetic damper - 3
4. "Pentium" processor - 1
5. star sensor - 1
6. Sun sensor - 2
7. magnetometer - 1
8. GPS receiver - 1

2. RESEARCH PROGRAM

Monitoring the atmosphere from space is conducted with the aid of the wide spectrum of the methods of remote sensing. Thus, for instance, for monitoring of the content of ozone it is used, as a rule, spectroscopy in the UV and visible region, monitoring sediments - in the radio-frequency band, temperature profiles - in the thermal range of spectrum. Such observations constantly are conducted from a number of spacecrafts (S/C). Also a number of other problems exist, which have great practical value, and are not solved generally, until now, or for which already long ago there are no fresh data.

As an example of this task - is monitoring of the complete content of CO2 in the atmosphere. Atmospheric carbonic acid, as basic greenhouse gas, plays the most important role in the climate of the Earth, absorbing the thermal radiation of the earth's surface, and preventing its emission into the space. Circulation of CO2 and of carbon generally in the atmosphere, the ocean and the biosphere to the high degree is controlled by natural factors, but it is known also that 30% of an increase of the concentration of this gas in the atmosphere in the last 100 years is the result of combusting of organic fuel and another activity of humanity. This led toward noticeable climate variations. The political aspect of this problem appears well known. At present moment in the world there are no satellites, which make it possible to solve this monitoring problem both globally, and at the regional level.

It is at present widely acknowledged that studies in physics of sun-earth connections not only give important fundamental results, but also are the focus of practical attention because of the observed influence of solar activity and terrestrial magnetic storms both on the reliability of operation of modern technical systems and on the biosphere (including humans). These studies confirmed the need for the applied information about the space weather of the wide circle of domestic users in the science, national economy, medicine and in other spheres. In connection with the development of the means of space communication and navigation, the occupation of northern territories, transpolar flight of civil aviation, etc., the dependence on the solar-space factors in the future will be strengthened only still more.

For the successful forecast [2, 3] and also for monitoring of the magnetic storms and other similar catastrophic disturbances the measurement of interplanetary space (solar wind), radiation of the Sun, magnetosphere and ionosphere, carried out by specialized S/C together with the ground observations are necessary. The plasma instruments [4] will be installed onboard the MS, that will make possible with the high time resolution to define the characteristics of near-earth space both in the quite time and during the catastrophic events [5] and the events of connected with variations in the "space weather". The fact is important that the micro-satellite ensure a maximally low level of onboard electromagnetic interferences, which usually hamper measurements on large S/C.

Today there are sufficiently developed satellite methods, which make it possible to ensure the monitoring of different dangerous phenomena on the earth's surface and evaluating their consequences. Such phenomena include both the natural cataclysms and the results of the human activity, which can lead to the irreversible changes in the environment. Modern technologies make it possible to use satellite data, for example, for monitoring of forest fires and floods, control of illegal traffic, evaluation of the influence of industrial objects on the environment and so forth for the solution of all these problems in short periods the creation of sufficiently cheap and operational systems is necessary. At present monitoring the earth's surface and forest fires, in particular, is conducted in Russia according to the data of foreign satellites. The use of micro-satellite with the contemporary onboard equipment will make it possible to create regional warning system with high technical characteristics [6].

The onboard camera, which will be installed at “Chibis”, is intended also for the optical observations of bolides and meteor showers in the Earth's atmosphere. The task of investigating

of statistical distribution and evolution of meteor showers, determination of the population of meteoric and cool flows by large fragments, the prognostic of the flare activity of the unsteady flows, the establishment of the structure of meteoric substance and correlation of the meteor showers with the parental proto-bodies is one of the most important directions of contemporary cosmogony. In connection with the problem of comet- asteroid danger and all with the increasing quantity of starting of automatic spacecraft the study of the distribution of small bodies in the near-earth space is extremely urgent.

Is planned also conducting the statistic studies of the distributions of the meteor showers and meteoroids, the determination of three-dimensional form and density of meteoroid it is swarming and the population of meteoric and bolid-like flows by large fragments, prognostication of the flare activity of the unsteady flows, and also obtaining of evaluating the average distances between the meteoric particles, the index of luminosity, particle distribution according to the masses (sizes), etc. Is assumed the application of the obtained results of space studies of meteoric substance for solving of cosmogonical problems, and also number of applied problems

3. BASIC CHARACTERISTICS OF THE “CHIBIS”

Weight	40 kg
Weight of scientific devices (MWC, CAS, CPE)	12,5 kg
Orbit	circular, altitude ~ 480 km
Time of active existence	not less than 1 year
System of orientation:	electromechanical; magnetodunamical; gravitational
Accuracy of orientation definition	up to 2 angle minute.
Accuracy of stabilization	+/- 3-5 angle minute.
System of transfer of the data: Board - Earth	128 kbyt/s
The Earth-board	9,6 kbyt/s.
Volume of memory TM	8 Mbytes.
Information from a board	~ 50 Mbytes / day.
Telemetry and telecommand link	145, 401, 435 MHz
Power	~ 50 W.

For the implementation of the scientific program on the "Chibis" will be established the complex of scientific instruments, which includes:

- spectrometer for measuring the complete content CO_2,
- digital camera of optical range,
- low-frequency flyx-gate magnetometer,
- serchcoil magnetometer,
- analyzer of the electromagnetic emissions,
- detector of ionosphere plasma.

It is assumed that on this micro-satellite will be carry out finalizing the set of contemporary scientific instrument, number of the procedures of observation, and also several new support systems. In the process of design is carried out the study of several versions of arrangement on the micro-satellite platform of nano-satellite by mass into 3-5 kilograms also of the mechanism of its separation from "Chibis". In this case can be somewhat increased the length of housing MS and its mass. The direction of the velocity vector of separation of nano-satellite from MS coincides with the zone of the field of view of the digital camera, established on the micro-satellite, which permits implementation of visual monitoring of the process of department and initial phase of the autonomous flight of nano-satellite. The first stage of this tandem could be

nano-satellite, which presents the reduced 3-4 times copy (on the external circumscriptions) of First artificial Earth satellite, but with the incomparably great functional possibilities. This flight can be realized into 50-th anniversary of the beginning of the Space Age in 2007.

The flight control and the reception of information, including images and spectra, is accomplished by a Centre of information reception and transmission of IKI RAN, located in Tarusa city, the Kaluga province.

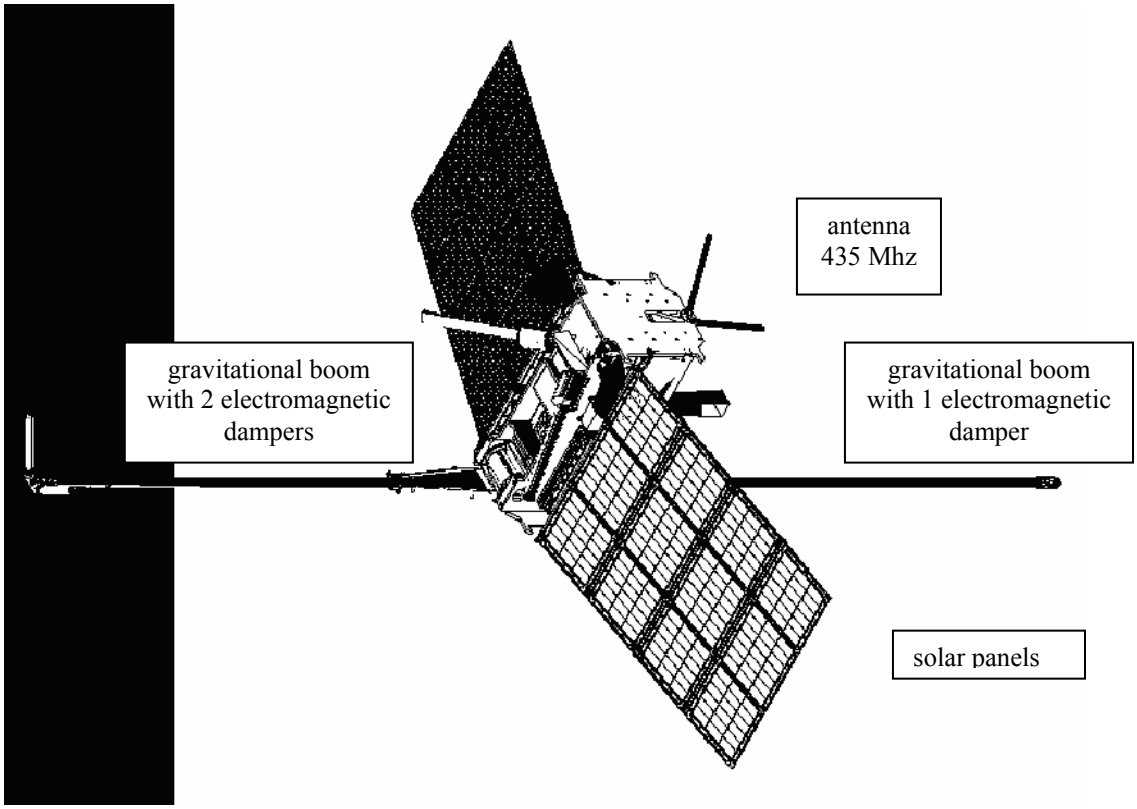

Figure 1. Main view of "Chibis" micro-satellite

4. AEROSPACE EDUCATION

Space today - the medium of active practical human activity. The results of the mastery of space are used in the science and technology, the need for their introduction in the formation ripened. Natural method to report the achievements of space studies to the general public - formation and its first step - school. Micro-satellite in this aspect are the unique teaching aids, comprised according to the principle from the simple to the complex and intended for the contemporary system of school formation [7].

Development, creation and use the MS requires training new specialists for their production and maintenance. The directed training of such specialists extremely must be begun as optional, already in the secondary school, improving subsequently these knowledge in university. This information, which bears educational nature, can be received by the School Centre of the Reception of Space Information (SCRSI), in particular, utilized in the implementation one with the use of a scientifically-educational micro-satellite "Kolibri-2000" (Obninsk, Kaluga, Korolev, Tarusa in Russia and Sydney in Australia).

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