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FUNDAMENTAL SPACE RESEARCHES IN RUSSIA

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The 4th VEP SCIENCE TEAM MEETING

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MAIN AREAS OF FUNDAMENTAL SPACE RESEARCH IN RUSSIA

Space plasma and the Solar physics:

- Studying of an internal heliosphere and the Sun from close distances;
- Studies of resonance interaction between electromagnetic radiation and charged particles of the Earth's magnetosphere;
- Studies of earthquakes' forerunners.

Research in astrophysics from space:

- High-accuracy astrometric measurements and precise definition of fundamental coordinate system;
- Astronomic objects observation in radio, ultraviolet, gamma, X-ray, millimeter and submillimeter ranges of spectrum.

Planets and small bodies of the Solar System researches:

- Studies of atmospheres, magnetosphere and surfaces of the Solar System planets;
- Expansion of the Solar System's small bodies researches, including the studies of the Phobos ground samples.

Basic problems of space biology, physiology and medicine:

- Carrying out research programs on study of microgravity and other spaceflight factors influence on processes of biological objects adaptation.

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FUNDAMENTAL SPACE STUDIES IN RUSSIA: **NEW PRINCIPLES OF PLANNING**

- **Lower costs;**
- **Emphasis on the use of light- and middle-class launch vehicles;**
- **Smaller projects with increased realization frequency;**
- **Maximum use of standardized units;**
- **Installation of scientific equipment as additional payload ("piggy back" launches) onboard the applied spacecrafts;**
- **Wider use of international co operation;**
- **Higher level of professional education.**

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MAIN AREAS OF FUNDAMENTAL SPACE RESEARCH IN RUSSIA

SCIENTIFIC AREAS	<u>PROJECTS</u> AND SEPARATE EXPERIMENTS
Research in astrophysics from space	<u>Spectr-R, Spectr-UV (World Space Observatory),</u> <u>Spectrum-RG/eRosita/Lobster, Konus-Wind,</u> Rim-Pamela, Nucleon, TUS, Gamma-400
Space plasma and the Solar physics	<u>Coronas-Photon, Resonans,</u> <u>Intergelioprobe</u>
Planets and the Solar System's small bodies research	<u>Phobos-Soil, Luna-Glob, Venera-D;</u> Installation of Russian scientific equipment on spacecraft Mars-Odyssey, LRO, MSL (NASA); Participation in creation of scientific equipment for spacecraft Mars-Express, Venus-Express, Bepi Colombo (ESA)

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ASTROPHYSICS AND COSMIC RAY PHYSICS

SCIENTIFIC AREAS

Research in astrophysics from space

PROJECTS AND SEPARATE EXPERIMENTS

Spectr-R,
Spectr-UV (World Space Observatory),
Spectrum-RG/eRosita/Lobster,
Konus-Wind,
Rim-Pamela, Nucleon, TUS, Gamma-400

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SPECTR - R



Scientific Objectives: allowing construction of images of astronomical objects, measuring their position and velocity with the accuracy up to one millionth of arc second, which provided by a network consisting of space radiotelescope and global network of ground based radiotelescopes.
Observations of super massive black holes in galactic nuclei,
Observation of black holes and neutron stars in our galaxy,
Observation of young stars and planets in star-birth regions in galaxies by their maser and megamaser emission,
Investigation of interstellar and interplanetary matter,
Construction a high accuracy celestial coordinate system,
Construction with high accuracy and exploration of Earth gravity field.

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World Space Observatory (Ultraviolet)



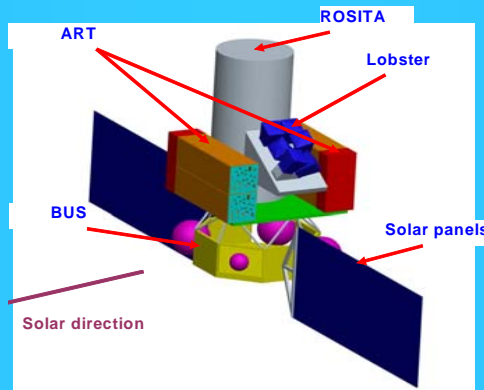
Supervision in a ultra-violet range of a spectrum (length of waves 110-340 nm), inaccessible to ground telescopes because of absorption of radiation by a terrestrial atmosphere, are key in the decision of fundamental problems of astrophysics:

- Cosmology and evolution of galaxies
- Physics accreting double systems
- Hot stars and the interstellar environment
- Comparative planetary meteorology

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Spectrum-RG/eRosita/Lobster



Scientific Goals:

All-sky survey by an imaging telescope in the 2-12 keV band to discover the hidden population of several hundred thousand obscured supermassive black holes and the first all-sky imaging X-ray time variability survey.

In addition to the all-sky surveys it is foreseen to observe dedicated sky regions with high sensitivity to detect ten thousands of clusters of galaxies and thereafter to do follow-up pointed observations of selected sources, in order to investigate the nature of Dark Matter and Dark Energy.

The proposed orbit provides an order of magnitude lower particle background than those of Chandra and XMM-Newton, which will allow the detailed study of low-surface-brightness diffuse objects.

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SOLAR PHYSICS, STUDIES ON SOLAR-TERRESTRIAL RELATIONS AND PROCESSES IN MAGNETOSPHERE OF THE EARTH

SCIENTIFIC AREAS

Space plasma and the Solar physics

PROJECTS AND SEPARATE EXPERIMENTS

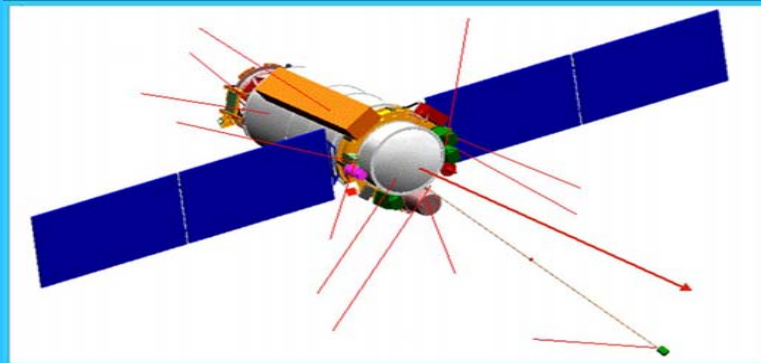
Coronas-Photon,
Resonans,
Intergelioprobe

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CORONAS-PHOTON



The project on research of processes of accumulation of energy and its transformation in energy of the accelerated particles during solar flashes, to studying of mechanisms of acceleration, distribution and interaction of vigorous particles in an atmosphere of the Sun, to research of correlation of solar activity with physical and chemical processes in the top atmosphere of the Earth

Main objectives of the mission

- Study of hard electromagnetic radiation dynamic in a wide energy range from EUV to 2000MeV;
- Nuclear gamma-lines spectroscopy of Solar activity regions;
- Detection of solar neutrons with energies higher 20MeV;
- Study of linear polarization and variability of hard X-ray emission;
- Monitoring of the Solar EUV, soft and hard X-ray emissions;
- Charge particle environment measurements;
- Simultaneously astrophysical observation including gamma-ray bursts;
- Monitoring of Earth upper atmosphere in EUV and soft X-rays radiated by the quiet Sun

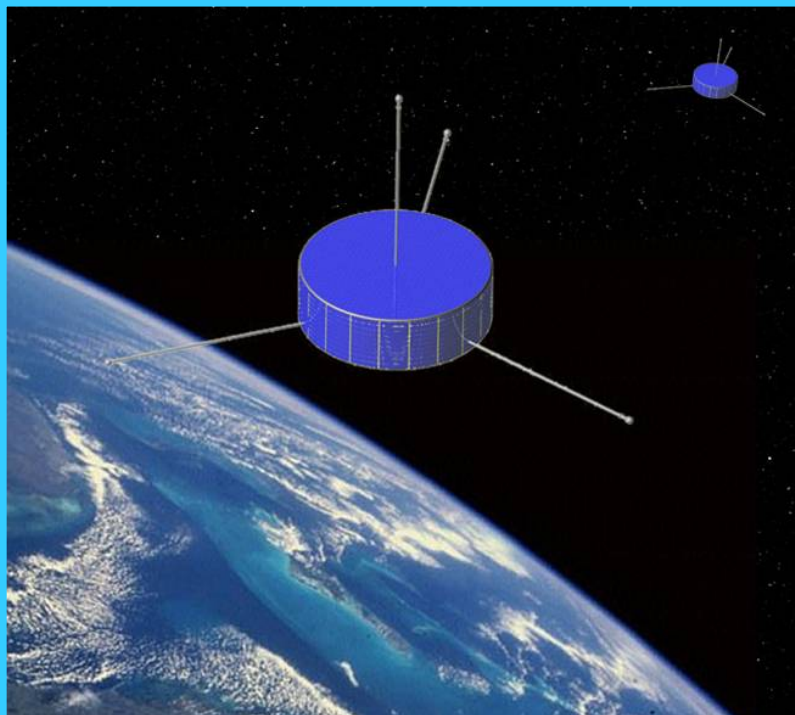
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RESONANCE

Study of wave-particle interactions and plasma dynamics in the inner magnetosphere



Main goals:

- Long-term observations of the natural phenomena, localized in the selected flux tube:
 - Dynamics of magnetospheres cyclotron maser,
 - Ring current formation,
 - Refilling of plasmosphere after magnetic storms,
 - Study of the role of the small-scale phenomena in the global plasma dynamics.
- An artificial influence on the operation of magnetospheric maser. Basic options:
 - Artificial excitation and/or stimulation of wave modes;
 - Modification of the flux of precipitating particles;
 - Variation of maser Q-factor by the modification of reflection index in the ionospheric footprint of the selected magnetic flux tube.

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INTERHELIOPROBE

Project of investigation the Sun and Inner Heliosphere

Ballistic scenario of the mission

- multiple gravity-assisted manoeuvres near the planet Venus (VGMs);
- electric propulsion low thrust system (in conjunction with VGMs).

Mission phases

- cruise phase (Earth-Venus);
- ecliptic phase (corotation);
- out-of-ecliptic phase (increase of orbit inclination up to 30-38° with respect to solar equatorial plane);
- perihelion lowering on inclined orbit (as possible).

SOLAR INSTRUMENTATION

- OPTICAL TELESCOPE
- MAGNETOGRAPH
- X-RAY IMAGER-SPECTROMETER
- CORONAGRAPH

HELIOSPHERIC INSTRUMENTATION

- Solar Wind Ion Analyzer
- Solar Wind Electron Analyzer
- Solar Wind Plasma and Dust Analyzer
- Magnetic Wave Complex
- Magnetometer
- Energetic Particle Telescope
- Neutron Detector
- Radio Spectrometer Detector
- Electron Gun

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EXPLORATION OF THE SOLAR SYSTEM PLANETS AND SMALL BODIES

SCIENTIFIC AREAS

Planets and the Solar System's small bodies
research

PROJECTS AND SEPARATE EXPERIMENTS

Phobos-Soil,
Luna-Glob,
Venera-D;

Installation of Russian scientific equipment on
spacecraft Mars-Odyssey, LRO, MSL (NASA);
Participation in creation of scientific equipment for
spacecraft Mars-Express, Venus-Express,
Bepi Colombo (ESA)

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PHOBOS-SOIL



Космический аппарат "Фобос-Грунт"
"Phobos Sample Return" spacecraft

About project:

The goal of "Phobos SOIL" mission is to bring to Earth soil samples from Mars' moon Phobos.

The launch of the spacecraft is planned for October 2009. Mission shall be finished in 2012.

According to Solar System celestial bodies classification - Phobos is a small body. It is of irregular shape which is approximated by ellipsoid with dimensions 13.3x11.1x9.3 km.

Landing on Phobos is planned to be performed in equatorial region on a side, constantly facing Mars.

The Lavochkin Association is the Prime Contractor for the development of Phobos Sample Return spacecraft.

Mission science program is developed in Space Research Institute (IKI) of the Russian Academy of Sciences in collaboration with other scientific organizations.

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PHOBOS-SOIL



Main facts:

Launch vehicle.....	Souz-2/1b
Launch sit.....	Baikonur Cosmodrome
Launch date.....	October 2009
Interplanetary Earth-Mars cruise duration.....	~ 11 months
Launch of Return spacecraft from Phobos.....	August 2011
Interplanetary Mars-Earth cruise duration.....	~ 11 months
Earth approaching date.....	July 2012
Mission total duration.....	~ 3 years
Spacecraft launch mass.....	8120 kg
Cruise module mass.....	1480 kg
Return spacecraft mass.....	210 kg
Scientific equipment mass.....	50 kg
Phobos soil samples mass.....	0.2 kg

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PHOBOS-SOIL

Properties:

- **modular desing of the spacecraft;**
- **housekeeping systems are developed as non-hermetic;**
- **cruise module and Return spacecraft can function as self-dependent spacecraft.**

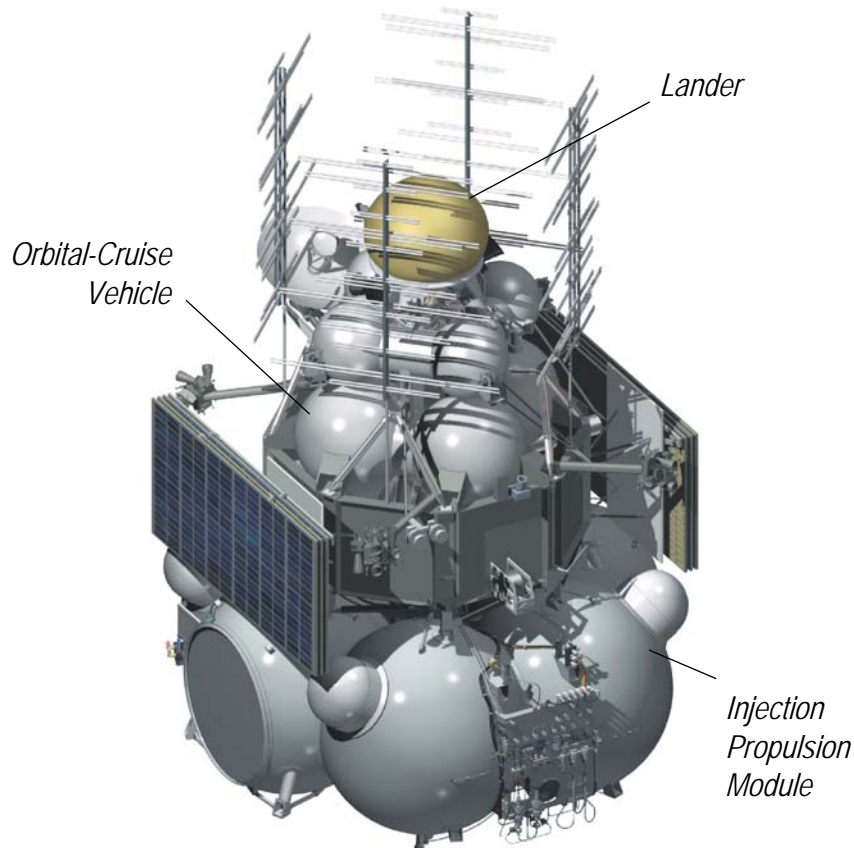


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LUNA-GLOB



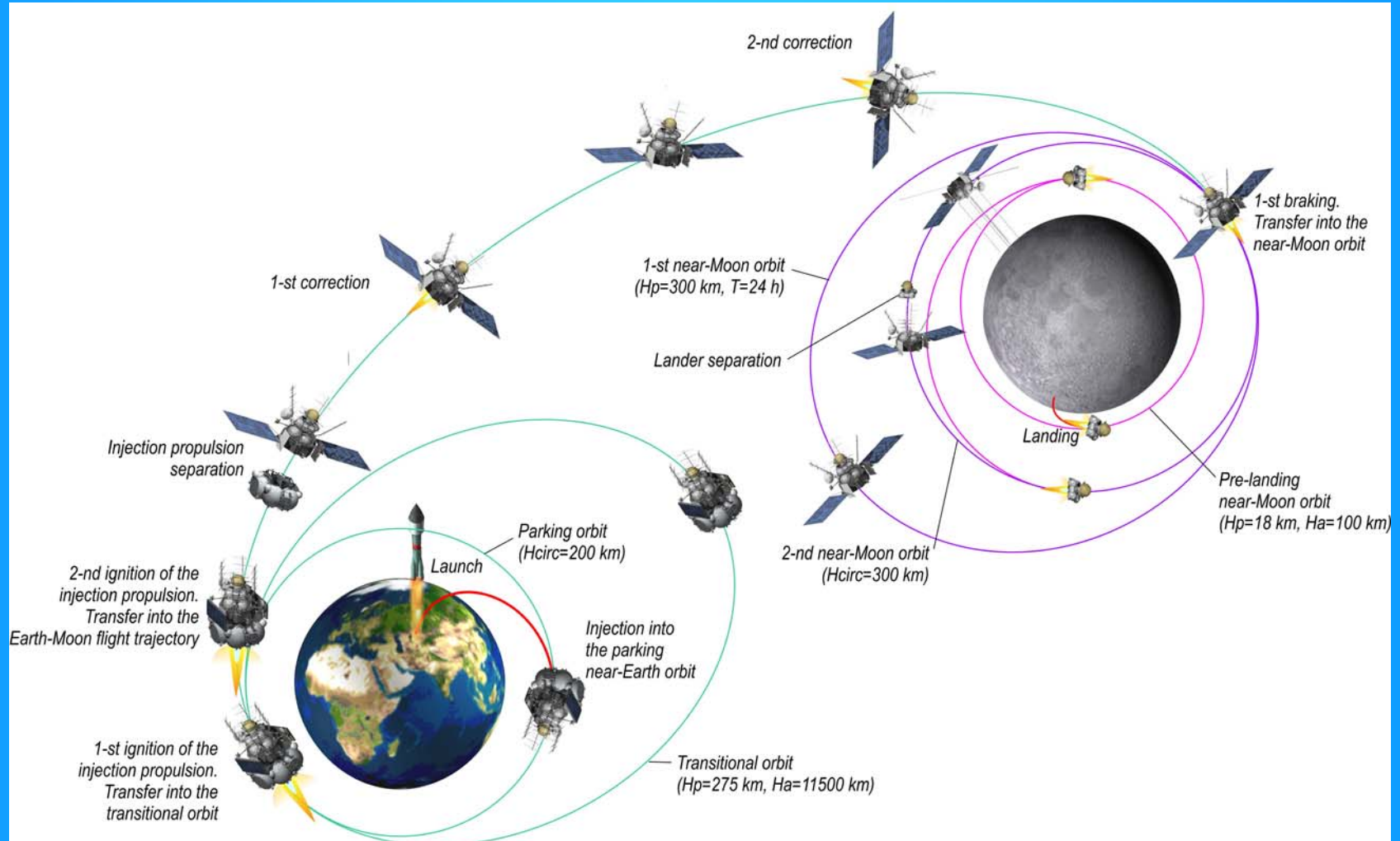
Scientific objectives of mission:

- Investigations of lunar inner structure;
- Intelligence lunar natural resources;
- Study influence particles and electromagnetic radiation on lunar surface;
- Determination of the volatile components in south pole crater of moon.

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LUNA-GLOB MISSION PROFILE



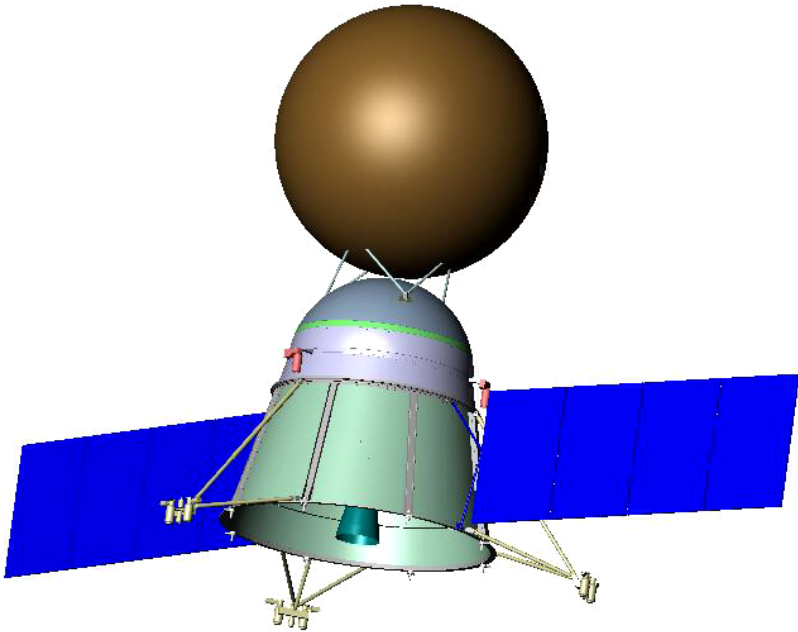
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VENERA-D

Mission for complex Venus investigations with use Orbiter, Lander and Balloons Flotilla.



Descent probe includes Lander and 3-4 Balloons. Balloons will be deployed at various locations and will float in the atmosphere at different latitudes and altitudes from 60 (in the clouds) to 10 km for more than one day, and some of them will land and work on the surface for more than one hour.

Rocket:	Soyuz-2
On orbit around the Earth	8120 kg
Near Venus	1900 kg
Descent Probe	1100 kg
On 3-day orbit	600 kg
Launch	2016 year

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SCIENTIFIC GOALS «VENERA-D» MISSION:

Orbiter (nominal life time 2 years (6 Venus days))

- The 3-D temperature and wind field in the middle atmosphere, its local time and temporal variations. Investigations of the thermal tides;
- Nature, composition and optical properties of the clouds;
- Nature of “unknown” UV absorber;
- Dynamics and nature of superrotation
- Chemical composition of the atmosphere: H₂O, SO₂, CO, HCl, HF etc.;
- Surface temperature, volcanic activity, lightning;
- Plasma environment.

Balloons

- Dynamics of the atmosphere;
- Meteorology (pressure, temperature density with high accuracy);
- Chemical composition and optical properties of the clouds;
- Chemical composition of the atmosphere;
- Imaging of the surface;
- Radiative balance and greenhouse effect;
- Surface temperature;
- Possible volcanic activity, lightning.

Lander

- Chemical composition of the atmosphere below 64 km
- Abundance (with high accuracy) of noble gases and isotopic composition;
- Clouds composition and optical properties;
- Radiative balance and greenhouse effect;
- Surface temperature, mineralogical characteristics;
- Possible volcanic and seismic activity, lightning.

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PRELIMINARY PAYLOAD «VENERA-D» MISSION:

Orbiter

- Fourier spectrometer for 0,9–50 μm - 25 kg
- Imaging UV-spectrometer 0,19–0,49 μm - 5 kg
- Wide-angle CCD camera with several channels 0,23–1,02 μm - 0,5 kg
- High resolution limb spectrometer - 5 kg
- Radiometer - 1 kg
- Radio Science - 1 kg
- Plasma complex (including Ion mass spectrometer - 2 kg) - 5 kg

Balloons

- Meteocomplex - 0,3 kg
- Mini fourier spectrometer - 1,5 kg
- CCD camera - 0,5 kg
- Nephelometer - 0,5 kg
- Radiometer - 0,5 kg

Lander

- Neutral mass spectrometer - 6 kg
- Experiment for surface properties investigations - 3 kg
- Meteocomplex - 0,3 kg
- Mini fourier spectrometer - 1,5 kg
- CCD camera - 0,5 kg
- Seismometer - 3 kg
- Nephelometer - 0,5 kg
- Radiometer - 0,5 kg

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Now a few words about
international cooperation

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What framework for international cooperation would be desirable to put into action related plans and ideas?

There are three main lines for cooperation:

- 1) Consulting and coordinating;
- 2) Division of labour and financial responsibility in space projects;
- 3) Investments.

They are profoundly different in terms of cooperation and scope of responsibility.

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Cooperation, foreseen sharing of labour and financial responsibilities in space programs

The best example of this collaboration is the experience of the activity of that created more than twenty years ago of quadrilateral working group - Inter-Agency Consultative Group (IACG) consisting of the representatives of NASA, ESA, Japan and USSR.

The task was the coordination of national and international space programs.

ESSENTIAL RESULTS :

- the studies of comet Halley by Russian, European and Japanese automatic spacecraft ;
- studies of the terrestrial magnetosphere by the Russian, Japanese , European and American automatic spacecraft.

The termination of activity IACG negatively influenced the international coordination of basic space research.

Negative result is

the limitation of the scope of the Mercury project "Bepi Colombo". Withdrawal from the principles of the coordination of projects and coordination of missions caused the reduction in the expected results of this project, since landing module was excluded from the project.

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Cooperation based on the sharing
of labour and financial responsibilities
in space programs

The problems of implementation :

1. to carry out national space programs within for more extended periods with the substantial financial stress;
2. to enter into the large scale international cooperation with the shared participation in the space projects.

The examples are Russian projects "Granat", "Astron", ISS. Further advances in space research and exploration are not feasible without the integration of basic space research activities . Integration is way to study the Venus, Moon, Mars and stars.

Examples are the projects of Roscosmos "World space observatory /Ultraviolet" and "Spectrum -RG/eRozita/Lobster". Projects "Interhelioprobe" (Roscosmos) and "Solar orbiter" (ESA) on solar research are possible as cooperative mission (s)

The gain is the decrease of the expenditures of each participant, the acceleration of the realization of project, an increase in the result of project and the larger contribution to the progress of the science and humankind.

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Investment cooperation

This activity is important for the involvement of the states, which do not have their space industry and are lacking the sufficient number of national scientific specialists.

It is necessary to grant to them the possibility to enter into the investment cooperation in the field of fundamental space research.

- 1. to ensure to such countries, the access of national scientific specialists to the scientific data of scientific space projects;**
- 2. to enlarge the region of the tasks of these projects (order of additional scientific gear with its subsequent starting on the projected automatic spacecraft);**
- 3. to carry out their own projects under the scientific management of its scientists.**

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Russia is opened

for the partner collaboration

on study of space !

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THANKS FOR YOUR KIND
ATTENTION