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USSR: Space

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Chronology of Cosmonaut Flight on 'Mir' Complex

Cosmonauts Experiment With 'Korund' Unit, Perform 'Rezonans' Experiment 18660102 Moscow PRAVDA in Russian 8 Jan 88 p 1

[TASS Report]

[Text] Flight Control Center, 7 January. The space tour of duty of Vladimir Titov and Musa Manarov on board the orbiting scientific research complex "Mir" is continuing.

Today's agenda for the crew calls for technical and technological experiments, observation of meteorological processes in the atmosphere, and installation of an additional unit in the complex's temperature-control system in order to expand possibilities for controlling its operation.

In line with the space materials-science program, the cosmonauts are engaged in optimizing methods for electrodeposition of corrosion-resistant coatings in conditions of zero gravity. An experiment with the "Korund" unit which began on 6 January is continuing. The purpose of this experiment is to grow single crystals of semiconductor materials with improved characteristics.

Performance of a "Rezonans" experiment is planned for the purpose of determining dynamic characteristics of the orbiting complex and evaluating the size of stresses which affect its structures.

Vladimir Titov and Musa Manarov are feeling well.

The flight is proceeding normally.

FTD/SNAP

/9604

Cosmonauts Perform Comprehensive Medical Exam

18660103 Moscow PRAVDA in Russian 12 Jan 88 p 2

[TASS Report]

[Text] Flight Control Center, 11 January. The third week of Vladimir Titov's and Musa Manarov's space mission has ended.

The crew of the orbiting complex conducted a comprehensive medical examination during the days just past. Results of this examination indicated that both cosmonauts are healthy and have adapted completely to the conditions of the mission. The commander's pulse rate is 66 beats a minute and the flight engineer's is 70 beats a minute. Their arterial pressures are 115 over 75 and 110 over 70 millimeters of mercury, respectively.

Today, comrades Titov and Manarov are conducting routine maintenance of onboard systems of the complex, and

they are preparing scientific equipment for upcoming work. Time is also reserved for engaging in physical exercises.

Space materials-science experiments and astrophysical studies are planned for tomorrow. Individual sections of the celestial sphere in the constellations Orion and Eridanus will be photographed with the aid of the ultraviolet telescope "Glazar."

According to reports from orbit and telemetry data, the flight of the manned complex "Mir" is proceeding normally.

FTD/SNAP

/9604

X-Ray, UV Astronomy Studies Aboard 'Mir' 18660104 Moscow PRAVDA in Russian 16 Jan 88 p 1

[TASS Report]

[Excerpt] Flight Control Center, 15 January. Cosmonauts Vladimir Titov and Musa Manarov are continuing to carry out the program of experiments on board the orbiting complex "Mir."

A substantial place in the crew's work during the days just past was reserved for studies of astrophysical objects in various wave bands. On 13 and 14 January individual areas of the constellations Orion and Puppis were photographed with the aid of the ultraviolet telescope "Glazar," and telescopes of the orbiting observatory "Rentgen" were aimed at an x-ray pulsar in the constellation Hercules.

Within the framework of the space materials science program, the cosmonauts performed several experiments for the purpose of further optimizing methods for electrodeposition of coatings in conditions of zero gravity.

Extra-atmospheric astronomy research using scientific apparatus of the "Kvant" module will be continued today. Photographing of the constellations Carina and Columba with the aid of the "Glazar" telescope is planned, in particular.

The day's agenda calls for routine preventive maintenance work on the station and for engaging in physical exercises.

According to telemetry data and the crew's reports, the flight of the scientific research complex "Mir" is proceeding normally.

Cosmonauts Vladimir Titov and Musa Manarov are healthy and feeling well.

FTD/SNAP

/9604

**Cosmonauts Continue Astrophysics Research,
Monitor Ocean Pollution**
18660105 Moscow PRAVDA in Russian 20 Jan 88 p 3

[TASS Report]

[Text] Flight Control Center, 19 January. The space mission of Vladimir Titov and Musa Manarov is continuing on board the orbiting complex "Mir."

Yesterday the crew performed the latest series of experiments using the ultraviolet telescope "Glazar." Their purpose was to obtain data on short-wave radiation of astrophysical objects in the constellations Leo and Ursa Minor. Telescopes of the "Rentgen" observatory were aimed at the supernova in the Large Magellanic Cloud.

A series of measurements of spectral characteristics of individual sections of the Earth's surface has been carried out within the framework of the program of geophysical research. One of the tasks of these studies was to determine the degree to which waters of the world's oceans are polluted with petroleum products.

Today, Vladimir Titov and Musa Manarov will be engaged chiefly in performing routine preventive maintenance work on board the complex. Sensing devices which have exhausted their service life are to be replaced.

Both cosmonauts are feeling well.

The flight of the manned complex "Mir" is proceeding normally.

FTD/SNAP

/9604

'Progress-34' Cargo Craft Launched
18660106 Moscow PRAVDA in Russian 22 Jan 88 p 1

[TASS Report]

[Text] In line with the program for further operation of the scientific research complex "Mir," an unmanned cargo spaceship, "Progress-34," was launched from the Soviet Union on 21 January at 0152 hours Moscow time.

The purpose of the launching of the spaceship is to deliver materials which become depleted and various cargo items to the manned complex "Mir."

The "Progress-34" ship was placed into an orbit with the parameters: maximum distance from Earth's surface—277 kilometers; minimum distance from Earth's surface—191 kilometers; period of revolution—88.8 minutes; inclination—51.6 degrees.

According to telemetry data, the onboard systems of the unmanned cargo ship are functioning normally.

FTD/SNAP

/9604

'Progress-34' Docks with 'Mir' Complex
*18660107 Moscow IZVESTIYA in Russian
24 Jan 88 p 1*

[TASS Report]

[Text] The cargo spaceship "Progress-34" docked with the manned complex "Mir" on 23 January 1988 at 0309 hours Moscow time.

The mutual search, rendezvous, approach and docking were carried out with the aid of onboard automation. These processes were monitored by the Flight Control Center interacting with the ground command-and-measurement complex, and also by cosmonauts Titov and Manarov.

The "Progress-34" ship docked with the complex at the end where the "Kvant" module is located. Fuel for the station's combined engine unit, foodstuffs, water, equipment and instruments, and also mail were delivered into orbit.

According to telemetry data and the crew's reports, the onboard systems of the manned complex "Mir" are functioning normally.

Vladimir Titov and Musa Manarov are feeling well.

FTD/SNAP

/9604

**Cosmonauts Continue Astrophysical Observations,
Conduct Physical Conditioning Experiment**
18660108 Moscow PRAVDA in Russian 23 Jan 88 p 1

[TASS Report]

[Text] Flight Control Center, 22 January. The flight of the orbiting scientific research complex "Mir," which is manned by Vladimir Titov and Musa Manarov, is continuing.

During the past 2 days, the crew performed several more series of astrophysical experiments using the orbiting observatory "Rentgen" and the telescope "Glazar," which records radiation in the ultraviolet part of the spectrum. The supernova in the Large Magellanic Cloud and individual areas of the constellations Ursa Minor and Carina were objects of research.

Measurements of flows of high-energy electrons and positrons in near-Earth space were continued with the aid of the "Mariya" apparatus.

In line with the plan of medical examinations, the cosmonauts conducted an experiment called "Sport"

yesterday. The purpose of this experiment is to determine optimal regimens of physical conditioning exercises—one of the most effective means of preventing adverse effects of weightlessness on the human organism.

The crew is to perform a number of medical-biological and biochemical studies today.

Vladimir Titov and Musa Manarov are feeling well.

The flight of the manned complex "Mir" is proceeding normally.

FTD/SNAP

/9604

Cosmonauts To Observe Increased Radiation From X-Ray Pulsar

18660109 Moscow PRAVDA in Russian 27 Jan 88 p 1

[TASS Report]

[Text] Flight Control Center, 26 January. Cosmonauts Vladimir Titov and Musa Manarov are in their 35th day of work on board the manned complex "Mir."

The crew has begun unloading the transport spaceship "Progress-34." Astrophysical and geophysical research and technological and medical-biological experiments are continuing.

Twenty-five series of studies have been conducted with the aid of the orbiting observatory "Rentgen." New information has been obtained on the evolution of the radiation spectrum of the supernova in the Large Magellanic Cloud.

According to data from optical measurements made on the ground, a sharp increase of flows of radiation has been recorded from a binary star system located in the Southern Hemisphere. This system includes an x-ray pulsar. Telescopes of the international observatory "Rentgen" will be aimed at this unique celestial object today and during the days immediately ahead.

In line with the space materials science program, the latest series of experiments has been completed for the purpose of optimizing methods for electrodeposition of corrosion-resistant coatings in conditions of zero gravity.

According to telemetry data and reports from orbit, the flight of the scientific research complex "Mir" is proceeding normally.

Vladimir Titov and Musa Manarov are feeling well.

FTD/SNAP

/9604

Cosmonauts Titov, Manarov Conduct Astronomy, Spectrometry, Materials Research

18660110 Moscow VECHERNYAYA MOSKVA in Russian 30 Jan 88 p 1

[TASS Report]

[Text] Flight Control Center, 29 January. The working day of Vladimir Titov and Musa Manarov began, as usual, at 0800 hours Moscow time. Today's program of work on board the manned complex "Mir" includes astrophysical and technological experiments, and also medical monitoring studies.

Observations of an x-ray pulsar in the Large Magellanic Cloud are continuing within the framework of the program of extra-atmospheric astronomy experiments. These studies are being made with the aid of the orbiting international observatory "Rentgen."

A series of experiments for further study of the mechanism by which elementary particles with high energies are generated in radiation bands of the Earth and in near-Earth space is being conducted with the aid of the magnetic spectrometer "Mariya."

The latest melt in the "Korund" unit is being completed in line with the space materials-science program. This melt has been conducted for the purpose of obtaining semiconductor materials with improved characteristics in conditions of extremely small gravitation.

Vladimir Titov and Musa Manarov will undergo a medical examination in the course of the day. One task of this examination is to evaluate reactions of the cardiovascular system to measured amounts of physical exertion.

The cosmonauts are feeling well.

FTD/SNAP

/9604

Results of Supernova Observations From 'Mir' Complex

18660111 Moscow KRASNAYA ZVEZDA in Russian 3 Feb 88 p 1

[TASS Report]

[Excerpt] Flight Control Center, 2 February. The space tour of duty of Vladimir Titov and Musa Manarov is continuing on board the manned complex "Mir."

Today's agenda for the crew calls for geophysical and astrophysical studies, monitoring of the functioning of equipment operating in the automatic mode, and engaging in physical exercises.

A substantial volume of observations of the supernova which flared up in the Large Magellanic Cloud on 23 February of last year has been made within the framework of the international program "Rentgen." Results of processing of data obtained have indicated that the flow of hard x-radiation from this astrophysical object during the last 2 months was more than 50 percent greater than the flow recorded during the period from August to October. The increase in the flow of radiation and the evolution of its spectrum indicate in particular that the supernova's shell has further clarified and that radioactive cobalt is not concentrated in the center of the shell but is distributed over a large space.

The weekly series of observations for calibrating and adjusting telescopes of the orbiting observatory "Rentgen" begins today. The pulsar in the Crab Nebula is being used as a standard source of radiation.

The work in orbit is proceeding in line with the designated schedule.

FTD/SNAP

/9604

Cosmonauts Work With EFO-1 Photometer, 'Mariya' Spectrometer

18660112 Moscow PRAVDA in Russian 6 Feb 88 p 2

[TASS Report]

[Text] Flight Control Center, 5 February. Vladimir Titov and Musa Manarov have been working on board the manned complex "Mir" for a month and a half.

Today the cosmonauts are conducting a series of experiments in line with the program of geophysical research. The purpose of these experiments is to determine optical characteristics of the atmosphere and obtain data on the aerosol layer at an altitude of about 100 kilometers. This work is being done with the aid of the electronic photometer EFO-1, using the method of measuring the brightness of stars as they set beyond the Earth's atmosphere.

The latest series of measurements of flows of elementary particles with high energies in near-Earth space is being made with the aid of the magnetic spectrometer "Mariya."

Calibration and adjusting of telescopes of the international orbiting observatory "Rentgen" by means of a source of radiation in the Crab Nebula is continuing in line with the plan of work with this observatory. Its telescopes are being aimed at the selected astrophysical object automatically; the crew is checking the prescribed orientation periodically and feeding corrections into the onboard computer complex as necessary.

Today's agenda calls also for a number of medical experiments and for engaging in physical exercises.

The flight is proceeding normally.

Vladimir Titov and Musa Manarov are feeling well.

FTD/SNAP

/9604

'Mir' Complex Passes One-Year Mark in Continuously Manned Mode

*18660113 Moscow IZVESTIYA in Russian
10 Feb 88 p 1*

[TASS Report]

[Text] Flight Control Center, 9 February. The orbiting scientific research complex "Mir" has been operating continuously in the manned mode for a year. Cosmonauts Vladimir Titov and Musa Manarov are now working on board the complex.

In line with the plan of routine preventive maintenance measures, the cosmonauts replaced a unit of the television communication system and checked the functioning of instruments and other equipment yesterday.

Today a substantial portion of the crew's working time is reserved for experiments aimed at further perfecting methods for electrodeposition of corrosion-resistant coatings in conditions of zero gravity.

According to results of medical monitoring, Vladimir Titov and Musa Manarov are in good health. The commander's pulse rate is 70 beats a minute and the flight engineer's is 68 beats a minute. Their arterial pressures are 120 over 80 and 115 over 75 millimeters of mercury, respectively. Both cosmonauts are feeling well.

FTD/SNAP

/9604

Crew Begins Preparing for EVA To Replace Section of Solar Panel

*18660114 Moscow SOTSIALISTICHESKAYA
INDUSTRIYA in Russian 13 Feb 88 p 4*

[Article by G. Lomanov, special correspondent at the Flight Control Center]

[Excerpt] "Vladimir and Musa, get ready to work with the 'tigr' on your next orbit."

What was happening on board the orbiting complex?

"Nothing exotic," said deputy flight director Viktor Dmitriyevich Blagov, with a smile. "Our TIGR is simply an acronym of 'holographic television interference detector for studying windows.' Substances from engine

exhausts settle on windows of the complex, and meteorites strike them in the course of a flight lasting for many months. Optical properties of the glass change, and we must know how they change in order to correct results of observations.

"We are preparing for an egress into open space. The crew will follow the path of Romanenko and Laveykin to the third solar battery which they installed. Titov and Manarov will lower it and replace one of the four parts of its panel. The new components are more efficient, and they age more slowly. Efficient structures and materials are being sought which will ensure the complex a reliable and steady power supply.

"This operation is planned for the end of February. The crew is now consulting with specialists, and we shall show the cosmonauts a film tentatively entitled 'Recollection' day after tomorrow. Preflight training in a tank filled with water at Star City is the subject of this film. Witnessing their own actions and recalling their sequence will be helpful to the crew."

FTD/SNAP

/9604

Cosmonauts Unload 'Progress-34,' Conduct Medical Examination

*18660115 Moscow IZVESTIYA in Russian
13 Feb 88 p 8*

[TASS Report]

[Text] Flight Control Center, 12 February. The latest week of Vladimir Titov's and Musa Manarov's work on board the orbiting complex "Mir" is ending.

During the days just past, the cosmonauts were engaged in unloading the spaceship "Progress-34," and they performed routine maintenance work on systems and equipment of the complex, as well as several series of space materials-science experiments.

The crew is conducting a medical examination today. It includes measurement of body mass, evaluation of the condition of muscles that are not exerted much in zero gravity, and study of the cardiovascular system.

The day's agenda calls for preparing the ultraviolet telescope "Glazar" for upcoming experiments.

Vladimir Titov and Musa Manarov are feeling well.

The manned complex "Mir" is now flying in an orbit whose parameters are: maximum distance from Earth's surface—371 kilometers; minimum distance from Earth's surface—337 kilometers; period of revolution—91.3 minutes; inclination—51.6 degrees.

FTD/SNAP

/9604

Cosmonauts Titov, Manarov Begin Ninth Week in Orbit

*18660116 Moscow IZVESTIYA in Russian
17 Feb 88 p 2*

[TASS Report]

[Text] Flight Control Center, 16 February. The ninth week of Vladimir Titov's and Musa Manarov's mission in orbit has begun.

The cosmonauts are continuing to unload the "Progress-34" spaceship while carrying out their program of scientific research. They are placing equipment that the spaceship delivered in rooms of the complex and replacing individual components of onboard systems which have exhausted their service life.

Refilling of tanks of the station's engine assembly with fuel has begun following pumping of compressed nitrogen out of the tanks.

In line with the medical monitoring plan, the crew is conducting a number of biochemical studies today, and also an experiment whose purpose is to evaluate the physical efficiency of muscles of the shoulder girdle.

The day's agenda calls also for preparations for work on further installation of new equipment on board the manned complex "Mir."

The flight is proceeding normally.

Vladimir Titov and Musa Manarov are feeling well.

FTD/SNAP

/9604

Cosmonauts Complete Unloading of 'Progress-34', Solar Battery Tested

*18660149 Moscow IZVESTIYA in Russian
3 Mar 88 p 1*

[TASS Report]

[Text] Flight Control Center, 1 March—The flight of the orbiting complex "Mir", which is manned by Vladimir Titov and Musa Manarov, is continuing.

The cosmonauts are completing work with the unmanned transport spaceship "Progress-34". They have placed cargo that the spaceship delivered in rooms of the complex, and they are filling an emptied compartment of the ship with used equipment. At the same time, fuel tanks of the station's combined engine assembly are being refilled with fuel and an oxidizing agent. The crew is monitoring these operations, which are being executed on commands from the onboard computer.

The experimental solar-battery section which Titov and Manarov installed during their egress into open space is being tested as a component of the "Mir" complex's power supply system. Specialists are now evaluating the operational effectiveness of the new photoelectric converters at different angles of their illumination by the sun.

The flight is proceeding normally.

both cosmonauts are feeling well.

FTD/SNAP

/9738

Details on New Solar Battery Section on 'Mir'
18660150 Moscow IZVESTIYA in Russian
28 Feb 88 p 1

[Article by A. Ivakhnov, special correspondent at the Flight Control Center]

[Excerpt] It was Vladimir Titov's and Musa Manarov's turn to make an egress into open space. Their voices were heard over the loudspeakers.

"The ["Mir" station's] solar battery consists of a lower unit and an upper one," explained specialists. "Each unit includes an extendable girder with two sections of photoelectric converters. In each section, there are eight rectangular panels which fold up into a packet like a children's folding book. Titov and Manarov have the task of folding the lower panels into packets, replacing one of them and then unfolding the battery again."

The new section differs from earlier ones in that the plates of its photocells are capsulized, so to speak; thin layers of glass fabric and glass plates protect them against adverse effects of space. They are made in such a way that power is stored both when the battery faces the sun and when the sun shines on its 'back'. Six panels of the new section provide as much power as eight panels of the packet that was removed. Two panels of the new section are experimental ones, with heightened production; on the lower panel are frames into which test prototypes can be fastened. The next time they go outside the station, the cosmonauts will be able to replace photocells in a matter of minutes. A large assortment of sensing devices is installed on the panels. Each of these devices will monitor some individual factor of space which affects photocells: micrometeorites, charged particles, gases from the engines of departing spaceships, etc. There is still another important difference. Instead of a metal alloy, a carbon-plastic composite material serves as the framework in the structure of the new section. This material is much lighter and far stronger than any alloy.

[On a television screen,] we watched Musa Manarov install, on the station's 'roof', specimens of promising materials, and also organic substances in a unit called

"Meduza". If the scientists are lucky, these substances will unite into more complex chains from the effect of space factors—chains similar to those from which life on our planet may have begun.

FTD/SNAP

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Cosmonauts Employ Attachment Devices for Work During EVA

18660151 Moscow KOMSOMOLSKAYA PRAVDA in Russian
27 Feb 88 p 1

[Article by S. Leskov, special correspondent at the Flight Control Center]

[Excerpt] Cosmonauts Vladimir Titov and Musa Manarov spent several hours in open space yesterday, performing installation work on board the orbiting station "Mir".

The lower quarter of the station's solar battery, which Yuriy Romanenko and Aleksandr Laveykin had unfolded during two strenuous egresses in June, had to be replaced. From the standpoint of rate of deterioration, photoelectric converters now installed are four times as reliable as before, related V. Vladimirov, a specialist. They could operate again and again. But progress must be made. And so good photodiodes were replaced with better ones.

"Are there any differences in Titov's and Manarov's scenario as compared with your own egress?," I asked Aleksandr Laveykin, who was watching his friends with interest as they repeated well-known operations.

"At the request of designers, Volodya and Musa fastened a special anchor to their legs," explained the cosmonaut. "Yuriy Romanenko and I floated freely in space, secured only by a flexible line. Which is better? All versions must be checked. In our case, there was more freedom to maneuver, but we had to cling to the ship with one hand. In their case, they had to stand in one place, but their hands were free."

FTD/SNAP

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Cosmonauts Inspect 'Progress-34' Antenna
18660152 Moscow TRUD in Russian
27 Feb 88 p 1

[Article by V. Golovachev, special correspondent at the Flight Control Center]

[Abstract] The article reports on activities of cosmonauts Vladimir Titov and Musa Manarov during their recent egress from the orbiting complex "Mir" to replace a section of a solar battery.

It is recalled that "Mir" was outside the zone of radio visibility when Titov and Manarov began their egress. Their next period of radio communication with the Flight Control Center took place at about 1300 hours. After completing the installation work on the panel, the cosmonauts went to the opposite end of the space station, proceeded along the outer surface of the module "Kvant" to the transport spaceship "Progress-34" and inspected an antenna of the spaceship to make sure that it was operating normally. This antenna had been late in opening before the spaceship docked with "Mir", it is explained. The space suits which the cosmonauts wore during the egress are said to be specially designed to protect the wearers against impacts of objects which may be encountered in outer space, including refuse, bits of metal and paint, and other objects ranging in size from 20 centimeters to less than a millimeter.

The solar-battery section was replaced for the purpose of testing new and more efficient cells of photoelectric converters in space-flight conditions. Specialists hope to convert the power supply of space stations from 27 volts to 110-220 volts with the aid of such cells.

FTD/SNAP

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Cosmonauts Titov, Manarov Perform Eva, Replace Section of Solar Battery
18660153 Moscow PRAVDA in Russian 27 Feb 88 p 1

[TASS Report]

[Text] Flight Control Center, 26 February. In line with the flight program of the manned complex "Mir", Vladimir Titov and Musa Manarov made an egress into open space today and installed an experimental section of a solar battery.

At 1230 hours Moscow time, the cosmonauts opened the outer hatch of the adapter module. They then carried the necessary equipment and tools to the outer surface of the station and moved to the area where installation work was to be performed on the third solar battery. This battery was installed on the station by Yuriy Romanenko and Aleksandr Laveykin in June of last year. Structurally, it consists of a lower and an upper unit, each of which includes an extendable girder and two sections of photoelectric converters.

With the aid of a special mechanism, the cosmonauts folded up the lower part of the battery's girder structure, detached one of its two sections and installed a new one in its place. After hooking up electrical connections, the crew again unfolded the solar battery to its full length.

The new section of the battery is equipped with prototypes of photoelectric converters made of semiconductor materials with improved power characteristics. The section is intended for testing various types of photocells in actual flight conditions for the purpose of increasing the solar batteries' operational efficiency and resistance to effects of open space.

Before returning to the station, the cosmonauts inspected external structural components of the complex, installed a number of scientific instruments and removed specimens of materials which had been exposed for a long time in conditions of open space.

The time that Vladimir Titov and Musa Manarov spent in open space was 4 hours and 25 minutes. They performed all of the planned operations on a high professional level. Both cosmonauts are feeling well.

(A photograph is given showing the cosmonauts at work outside the station. The photograph was transmitted via space telecommunications.)

FTD/SNAP

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Cosmonauts Continue EVA Preparations
*18660154 Moscow IZVESTIYA in Russian
24 Feb 88 p 1*

[TASS Report]

[Text] Flight Control Center, 23 February. Vladimir Titov and Musa Manarov have been on duty on board the orbiting complex "Mir" for two months.

As has already been reported, the crew is now making preparations for an upcoming egress into open space. The cosmonauts have checked the airtightness of spacesuits and the functioning of their life-support systems and of communications equipment, and they have prepared the necessary apparatus and tools. Equipment intended for installation is being placed by the cosmonauts in the adapter module, which is used as a lock chamber during egresses into space.

According to results of medical monitoring, Vladimir Titov and Musa Manarov are feeling well.

The microclimate parameters in the complex's living compartments are: temperature—20 degrees Celsius; atmospheric pressure—739 millimeters of mercury.

FTD/SNAP

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Cosmonauts Prepare for EVA to Install Solar Battery Section

18660155 Moscow PRAVDA in Russian 20 Feb 88 p 1

[TASS Report]

[Text] Flight Control Center, 19 February. The station "Mir", which was placed into orbit on 20 February 1986 is continuing to function in near-Earth space. Vladimir Titov and Musa Manarov are now on a space mission on board the station.

The crew's flight program calls for an egress into open space to be made at the end of this month for the purpose of installing a section of an experimental solar battery which was delivered into orbit by the cargo spaceship "Progress-34".

The cosmonauts have begun preparing for installation operations for this purpose. They are to check equipment and gear needed for the egress and refine and perfect a procedure for performing operations on the outer surface of the station. Today the crew is engaged in inspecting space suits and checking their airtightness, in particular.

According to results of a medical examination, the state of health of Vladimir Titov and Musa Manarov is good, and they are feeling well.

FTD/SNAP

/9738

'Progress-34' Destructive Reentry

18660156 Moscow IZVESTIYA in Russian 5 Mar 88 p 1

[TASS Report]

[Text] Flight Control Center, 4 March. The flight of the unmanned transport spaceship "Progress-34", which was launched into a near-Earth orbit on 21 January 1988, has ended.

The cargo ship docked with the manned complex "Mir" on 23 January. Operations planned for the period of joint flight, including unloading the ship, transferring drinking water and refueling the station's engine assembly, were fully completed.

The "Progress-34" spaceship was separated from the orbiting complex "Mir" today at 0640 hours Moscow time. The ship was then oriented on commands from the Flight Control Center, and its engine was fired. As a result of braking, "Progress-34" went into a descending trajectory, entered the dense layers of the atmosphere, and ceased to exist.

During the days just past, cosmonauts Vladimir Titov and Musa Manarov underwent a medical examination, conducted experiments for evaluating dynamic charac-

teristics of the orbiting complex, and prepared scientific apparatus for upcoming research.

In line with the space materials-science program, the crew is beginning a series of experiments today whose purpose is to study features of processes of the melting and crystallization of various materials while they are being heated by a concentrated flow of radiation. A technological unit, a mirror-beam furnace, is being used in this research.

According to results of medical monitoring, the condition of the cosmonauts' health is good, and they are feeling well.

The work in orbit is continuing.

FTD/SNAP

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Cosmonauts Perform Materials Studies, Medical Monitoring

18660157 Moscow SOVETSKAYA ROSSIYA in Russian 12 Mar 88 p 1

[TASS Report]

[Text] Flight Control Center, 11 March. The latest work week of Vladimir Titov and Musa manarov on board the orbiting complex "Mir" is ending.

During the two days just past, the crew was engaged mainly in conducting space materials-science studies. A series of experiments employing model liquids was performed in the unit "Pion-M" for the purpose of further studying processes of heat and mass transfer in conditions of extremely small gravitation.

Today's agenda calls for medical monitoring of the cosmonauts and for technological and technical experiments.

The latest series of extra-atmospheric astronomy studies has begun. Today such studies are being made with the aid of the orbiting observatory "Rentgen", in particular.

On Saturday and Sunday, Vladimir Titov and Musa Manarov will rest. During their free time, the cosmonauts listen to music and watch video recordings. The manned complex also has an onboard library of several dozen volumes. It includes both classical literature and works on cosmonautics by our fellow countrymen.

According to telemetry data and reports from orbit, the flight of the orbiting scientific research complex "Mir" is proceeding normally. Both cosmonauts are feeling well.

FTD/SNAP

/9738

Cosmonauts Titov, Manarov Continue Research, Medical Studies

18660158 Moscow PRAVDA in Russian 19 Mar 88 p 1

[TASS Report]

[Text] Flight Control Center, 18 March. Cosmonauts Vladimir Titov and Musa Manarov are continuing planned

work on board the scientific research complex "Mir". Several more series of photographing of different areas of the starry sky in the ultraviolet frequency range have been performed within the framework of the extra-atmospheric astronomy research program. These experiments will be continued today. The ultraviolet telescope "Glazar" will be aimed at an area of the constellation Ursa Major.

The latest experiment in the technological unit "Pion" has been completed in line with the space materials-science program. This experiment is being conducted for the purpose of studying features of structure formation by colloidal solutions in conditions of extremely small gravitation.

The crew's program of work for today includes two medical examinations. An experiment called "Akustika" is being conducted for the purpose of studying background noise in work areas and living rooms of the manned complex.

In the course of the day, both cosmonauts will also undergo examinations for the purpose of evaluating visual acuity.

According to reports from the crew and telemetry data, the flight is proceeding in accordance with the designated program.

Vladimir Titov and Musa Manarov are feeling well.

FTD/SNAP

/9738

Titov, Manarov Complete Third Month in Orbit
18660159 Moscow PRAVDA in Russian 23 Mar 88 p 1

[TASS Report]

[Text] Flight Control Center, 22 March. The crew of the scientific research complex "Mir", Vladimir Titov and Musa Manarov, has completed its third month of work in near-Earth space.

During the days just past, the cosmonauts carried out routine preventive operations for technical maintenance of onboard systems of the base block and of equipment and apparatus.

In line with the program of technical experiments, one more series of operations has been performed for the purpose of evaluating the effectiveness of star identification with the aid of new optical instruments. In accordance with the plan for installing additional equipment on board the station, a new phototelegraphic system is being tested which is intended for transmitting scientific-technical information to the manned complex.

Experiments for studying the distribution of flows of micrometeorites in near-Earth space are being continued

with the aid of equipment installed on the outer surface of the station. Information on the course of these experiments is being received on Earth via telemetry channels.

The Flight Control Center sent birthday greetings to Musa Manarov during the first morning period of communications today. The crew's flight engineer is now 37.

The cosmonauts will meet with their families and friends during periods of television communication in the evening.

According to results of medical monitoring and reports from orbit, the condition of Vladimir Titov's and Musa Manarov's health is good, and they are feeling well.

FTD/SNAP

/9738

Launch of 'Progress-35' Cargo Ship
*18660160 Moscow IZVESTIYA in Russian
25 Mar 88 p 1*

[TASS Report]

[Text] In line with the program for further operation of the scientific research complex "Mir", an unmanned cargo spaceship, "Progress-35", was launched from the Soviet Union on 24 March at 0005 hours Moscow time.

The purpose of the launching of the spaceship is to deliver materials which become depleted and various cargo items to the manned complex "Mir".

The "Progress-35" spaceship was placed into an orbit with the parameters: maximum distance from Earth's surface—280 kilometers; minimum distance from Earth's surface—190 kilometers; period of revolution—88.9 minutes; inclination—51.6 degrees.

According to telemetry data, the onboard systems of the unmanned cargo spaceship are functioning normally.

FTD/SNAP

/9738

Cosmonauts Prepare for Docking of 'Progress-35'
*18660161 Moscow IZVESTIYA in Russian
26 Mar 88 p 4*

[TASS Report]

[Text] Flight Control Center, 25 March. Vladimir Titov and Musa Manarov have been working in near-Earth orbit for 95 days.

They are now engaged chiefly in preparations for receiving the cargo spaceship "Progress-35", which is scheduled to dock with the manned complex "Mir" at the beginning of the next 24-hour period. The crew also has to conduct a number of medical-biological experiments in the plan of scientific research.

During the past two days, the cosmonauts performed another series of experiments for studying features of structure formation by colloidal solutions in zero gravity, and they measured the level of background noise in living rooms and work areas of the complex.

The work in orbit is proceeding in accordance with the designated schedule.

FTD/SNAP

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'Progress-35' Docks with 'Mir' Complex
18660162 Moscow IZVESTIYA in Russian
27 Mar 88 p 1

[TASS Report]

[Text] The cargo spaceship "Progress-35" docked with the manned complex "Mir" on 26 March 1988 at 0122 hours Moscow time.

The mutual search, rendezvous, approach and docking were carried out with the aid of onboard automation. These processes were monitored by the Flight Control Center interacting with the ground command-and-measurement complex, and also by cosmonauts Titov and Manarov.

The "Progress-35" spaceship docked with the complex at the end where the "Kvant" module is located. Fuel for the station's combined engine unit, foodstuffs, equipment and instruments, and also mail were delivered into orbit.

According to telemetry data and the crew's reports, the onboard systems of the manned complex "Mir" are functioning normally.

Vladimir Titov and Musa Manarov are feeling well.

FTD/SNAP

/9738

**Cosmonauts Begin Unloading 'Progress-35',
Conduct Medical Examination**
18660163 Moscow PRAVDA in Russian 30 Mar 88 p 1

[TASS Report]

[Text] Flight Control Center, 29 March. The space mission of Vladimir Titov and Musa Manarov is continuing.

Since the arrival of the unmanned cargo spaceship "Progress-35", the cosmonauts have been engaged in placing cargo items which the spaceship delivered in

rooms of the complex, and they are replacing individual components of onboard systems which have exhausted their service life.

While unloading the spaceship and carrying out routine preventive-maintenance measures, the crew is simultaneously continuing to execute the scientific program of the mission. A series of geophysical experiments for further study of the Earth's ionosphere and magnetosphere was performed yesterday, in particular.

The cosmonauts also underwent a medical examination. According to its results, the condition of Vladimir Titov's and Musa Manarov's health is good. The commander's pulse rate is 67 beats a minute and the flight engineer's is 73 beats a minute, and their arterial pressures are 115 over 70 and 110 over 70 millimeters of mercury, respectively.

The flight of the orbiting scientific research station "Mir" is proceeding normally.

FTDS/SNAP

/9738

Cosmonauts Continue Astronomy, Spectrometry Studies

18660164 Moscow SOVETSKAYA ROSSIYA in Russian 2 Apr 88 p 1

[TASS Report]

[Text] Flight Control Center, 1 April. The working day of cosmonauts Vladimir Titov and Musa Manarov began at 0900 hours Moscow time. Today's agenda on board the manned complex "Mir" calls for astrophysical and technical experiments, medical monitoring of the crew, and engaging in physical exercises.

Experiments using the orbiting observatory "Rentgen" are continuing within the framework of the international program of extra-atmospheric astronomy research. The observatory's telescopes are aimed at the x-ray source Cygnus X-1 today.

Highly precise aiming of x-ray telescopes at objects of research is accomplished automatically by means of the "Kvant" module's powered gyrostabilizers and of onboard computers. The cosmonauts check the precision of the telescopes' orientation periodically and correct the operation of automatic equipment as necessary, using navigation equipment.

A series of experiments for further study of the mechanisms by which high-energy particles are generated in the Earth's radiation belts and in near-Earth space will be conducted in the course of the day, using the magnetic spectrometer "Mariya".

According to telemetry data and the crew's reports, the onboard systems of the orbiting complex "Mir" are functioning normally.

Vladimir Titov and Musa Manarov are feeling well.

FTD/SNAP

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Cosmonaut Romanenko Comments on 326-Day Mission

*18660165 Moscow IZVESTIYA in Russian
3 Feb 88 p 3*

[Article by A. Ivakhnov, correspondent]

[Abstract] The article is an interview with Yuriy Viktorovich Romanenko, pilot-cosmonaut of the USSR, regarding memorable events of his 11-month mission on board the orbiting complex "Mir". The interview was given in Kislovodsk, where Romanenko and the other members of his space crew were vacationing. An editorial preface to the article mentions that the author was forbidden to see Romanenko, immediately after arriving in Kislovodsk and that the interview had to be shortened, for medical reasons. Specialists explained that metabolic processes of the cosmonauts which were affected by prolonged weightlessness still had not been completely normalized, and that precautions had to be taken against infection with influenza in particular.

In the interview, Romanenko comments on the egress which he and flight engineer Aleksandr Laveykin made in order to dock the module "Kvant" securely with the "Mir" station. The object which was interfering with the docking of the module turned out to be a nylon bag containing personal-hygiene articles, Romanenko recalls. The bag had blown through a crawlway and into the station's docking mechanism during preparations for separating the most recent "Progress" spaceship from "Mir". The module had to be moved back to the maximum angle in relation to the station, and Romanenko and Laveykin had to do this manually. Since the combined weight of the module and its engine was 20 tons, this was an original accomplishment in itself, and it provided experience which can be used in the future in assembling large objects in orbit, Romanenko observes. An alarming incident occurred during the egress: Laveykin reported that the pressure in his space suit was dropping. Romanenko recalls that he immediately checked the suit's pressure regulator and found that it was set on "low". Its control knob had been moved to that position by accidental contact with the edge of the hatch, while the cosmonauts were going outside the station. protective screens for the regulator controls were delivered to the station by the next cargo spaceship and installed before the cosmonauts made their next egress.

Asked if this event had any bearing on the early termination of Laveykin's mission, Romanenko relates that the flight engineer experienced an extra systole at the time it occurred but points out that this is a natural reaction to stress. He believes that Laveykin could have completed his mission if the visiting expedition had not provided an opportunity for returning him to Earth. Romanenko criticizes medical personnel of the Flight Control Center for not informing the primary crew of the decision to recall Laveykin until a week before the visitors arrived. He relates that this announcement came as a shock to the flight engineer, whose immediate reaction was one of despair. Romanenko notes with satisfaction that Laveykin has been declared fit for space duty following postflight examinations and treatment.

Romanenko hesitates to assess prospects for space missions longer than his own, pointing out that not all consequences of such prolonged stays in space can be predicted on the basis of present experience. This applies to both his own crew and the present crew of "Mir". He states from personal experience that unforeseeable stress situations and even minor hardships which occur during missions may be difficult for some cosmonauts to endure over a period of a year or longer.

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Medical Status of Cosmonaut Romanenko After 326-Day Flight

*18660166 Moscow KRASNAYA ZVEZDA in Russian
31 Jan 88 p 3*

[Article by M. Rebrov, Colonel, correspondent (Kislovodsk and Moscow)]

[Abstract] The article comments on the state of health of cosmonauts Yuriy Romanenko, Aleksandr Aleksandrov and Anatoliy Levchenko during their recent mission on board the orbiting complex "Mir" and period of post-flight adaptation to terrestrial conditions. The author responds to speculation which has appeared recently in the Western press, particularly allegations that Romanenko had to return to Earth a month ahead of schedule because of serious changes in his physical and mental condition, and that the cosmonaut still suffers from faintness.

It is recalled that when Romanenko's 326-day mission began, journalists knew that it was scheduled to end on December 29. An account is given of a visit which the author of the article made recently to Kislovodsk, where Romanenko, Aleksandrov and Levchenko were vacationing with their families. In a conversation, Romanenko related that muscles which he had not exerted during the space mission still felt weak, but that all of his parameters were stable. I. Tarasov, who was in charge of

medical preparation of the cosmonauts, and I. Reznikov, the crew's physician, were confident that Romanenko would return from his record-setting mission completely fit, they recalled.

General-Lieutenant of Aviation V. Shatalov, a pilot-cosmonaut and head of the Cosmonaut Training Center, praised special conditioning methods which physicians of the center and other medical specialists have developed for space crews. These methods are intended for use during the period of preparation for a prolonged mission, and also during work in orbit. Thanks to them, Romanenko and the other members of his crew kept themselves in a condition which would have enabled them to fly to the planet Mars, carry out research there and return to Earth, Shatalov claimed. His opinion was supported by pilot-cosmonauts A. Leonov and P. Klimuk.

In an appendix to the article, academician O. Gazenko presents a scientist's opinion of Romanenko's condition. Results of postflight examinations and other data which have been obtained are said to indicate that Romanenko maintained a sufficiently high level of working fitness over the course of the entire mission. "There was practically no change in the cosmonaut's weight, which is a very important integral indicator of the state of a person's health," Gazenko reports. "Shin muscle volume decreased slightly, but no more, and this change was even somewhat less as compared with a number of other prolonged missions. Optical density of bone tissue—an index of bone strength—decreased by approximately 5 percent. This is less than decreases noted in other missions. The character of functional changes in the cardiovascular system, which is particularly vulnerable to effects of weightlessness, did not differ from that which we had observed previously." Gazenko relates that Romanenko's period of postflight readaptation is proceeding successfully. The overall condition of the cosmonaut's health has been largely in keeping with medical prognoses based on earlier experience and on data obtained in the course of the mission.

FTD/SNAP

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Soviet-French Cosmonaut Crews Perform Survival Training Exercises

18660167 Moscow MOSKOVSKAYA PRAVDA in Russian 6 Mar 88 p 3

[Article by I. Davydov]

[Abstract] The article gives an account of winter survival training exercises of two crews of Soviet and French cosmonauts who are scheduled to carry out a space mission in November-December, 1988. Extreme conditions which a crew may encounter at its point of landing were simulated as closely as possible in these exercises.

In the course of the exercises, the cosmonauts practiced techniques for surviving in severe cold while waiting for search and rescue teams to locate them. A point of landing can be calculated with an accuracy of only tens of kilometers even under normal conditions, it is explained. If an emergency forces a crew to make an immediate descent from orbit, its landing place may be far outside the usual area, in a zone where climatic conditions are extreme.

The Soviet-French crews' training exercises were conducted in a forest near Moscow, under the supervision of a group of instructors. A crew consisting of Aleksandr Viktorenko, pilot-cosmonaut of the USSR, and French cosmonaut Michel Tognini took part in the first exercise. They spent a night in a spaceship which had been brought to the place of the exercise. The trainees wore insulated suits and took turns operating the ship's radio equipment. In the morning, they removed the parachute from the spacecraft, readied signaling equipment for operation, and built an emergency shelter, using materials from the ship. They dug a trench in the snow, lined the trench with space suits and fabric from the spaceship's inner lining, and improvised a roof for the shelter out of a medical cape, inflatable craft and a multilayer parachute fabric. Aleksey Leonov and the director of the exercises visited Viktorenko and Tognini at the end of the day. Leonov tested a pyrotechnic signaling pistol in whose development he had taken part. On the following morning, Viktorenko and Tognini left the 'landing place' on foot, wearing knapsacks improvised from parachute fabric and carrying their radio set and signaling pistol with them. The exercise ended when the cosmonauts made contact with a search party traveling on special off-road vehicles.

The second crew, which consists of Aleksandr Volkov, pilot-cosmonaut of the USSR, and French cosmonaut Jean-Loup Chretien, began its training exercise on the following night, in colder weather. The cosmonauts built a shelter out of snow blocks and a parachute canopy, made a bonfire, and used pieces of a metalized medical cape as a blanket to keep their legs warm. Leonov and Yuriy Glazkov visited them on the following day. Volkov and Chretien spent another night at their 'landing place', then hiked to an area where tents had been set up for medical examinations of the cosmonauts on the completion of the exercise.

A photograph is given showing Volkov and Chretien in the forest, working with equipment of the spaceship.

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Cosmonaut Volk Discusses Aircraft Test Flights After Return From Space Missions

Moscow PRAVDA in Russian 4 Mar 88 p 4

[Interview with Cosmonaut Igor Volk by A. Tarasov: "From Space in an Aircraft!"]

[Excerpts] Cosmonaut Igor Volk, Hero of the Soviet Union and USSR Meritorious Test Pilot, is one of the

participants in the Soviet reusable spaceship program. Many readers interested in this project have addressed letters to him. A. Dunayev, head of the USSR Glavkosmos, recently reported on this at a press conference.

The conversation with Igor Volk was no simple matter. First of all, it is virtually impossible to catch the test pilot on the ground. Second, he is a man of extremely few words and is reserved. Everything which pertains to his own experiences he regards as being of secondary importance. But the readers gave us precisely this assignment: to learn what the participant in this new space work does, thinks and experiences.

I see fatigue in Volk's eyes because he is still living on Kamchatka time, from whence he has just returned. There it is already morning, but here it is necessary to work on. But another bit of time will not be excessive and therefore I overcome my feeling of guilt and Volk overcomes his sensation of fatigue. Interviewer: Many readers are interested in our "shuttle" and at the same time are asking whether we are lagging behind the Americans...

Volk: And just why must work in space be regarded as a speed race, a stadium competition? Who's ahead? The universe is infinite and there is no finish line there. Each country selects a goal which is within its capability and which is necessary at a particular time, investing its energies and resources in its accomplishment. As a flier, I would also like to be the first in the world to take up such a ship and take it beyond the boundary of the atmosphere. But these are matters of vanity and they have no place here. As an engineer I comprehend that it is necessary to solve an enormous number of problems, primarily scientific and technical, in which every link is important and each requires the greatest attention. The "Challenger" example illustrates the tragic price of haste, the atmosphere of a race... It is not a matter of who makes a ship first, but of attaining a new stage in the use of space technology. A ship must operate in space performing only the functions of which it is capable. It does not replace a long-term orbital station, for example, or a technological apparatus. But it enhances their significance by operating in conjunction with them.

Interviewer: How many air-space ships, for example, do you visualize in their full development?

Volk: A great number. They must perform the same work as is now done by Aeroflot. But the sphere of operations will be expanded, reaching into space.

Interviewer: Recently, after return of the Soviet-Syrian crew from the "Mir" station, we saw how Anatoliy Levchenko headed for a TU-154 aircraft for making a flight. Are such flights also test flights?

Volk: To be sure. Anatoliy coped very well with this work. He is entering the program for training for flights in manned reusable ships. Interviewer: In his time Igor Volk also went "from ship to a ball." The ship was the descent module of the "Soyuz T-12," in which in late July 1984 he returned from the "Salyut-7" together with Vladimir Dzhanibekov and Svetlana Savitskaya. And the "ball" was the piloting of aircraft after 12 days of weightlessness. By that time his flight experience was about 5000 hours. Among these thousands of hours a very great number were in difficult test situations. He is proud that he flies in virtually all aircraft which are produced by our aviation industry and that he has been able to test himself in all aspects of the enormous field of test flight activity. His examiners, instructors, and later, comrades in the sky were truly great: Kokkinaki, Anokhin, Garnayev, Amet-khan, Gudkov... He was also examined in flights with spins and with commands for catapulting, remaining, incidentally, unperformed. The typical life of a test pilot, he says, and willingly proceeds to praise of his comrades. But I would like to learn "firsthand" in what way this "post-weightlessness" flight differed from all others. Indeed, it has its own special character.

Volk: Well, taking it in order, says Igor Petrovich smiling, I experienced the first "nuance" when for 20 minutes I hung upside down in the restraints in the descent module. I could not figure out at once which bolt was stuck. After this I could not stand on my feet and walk from the ship to the helicopter. I was carried in a chair, although that was excessive. Here I had to part from Svetlana and Volodya; they were in the medical examination tent, whereas I underwent an orthostatic test directly in the helicopter: supine, sitting, standing up. Then I was immediately in flight, heading for an airfield where an aircraft awaited. But waiting was uninteresting. I asked the helicopter commander for the controls and he sat in the right seat, behind the second. And thanks to him I controlled the helicopter until it landed. Although he naturally did not trust me entirely for the landing itself. Prior to the takeoff I had forgotten to bring my flight gear. I arrived in the aircraft without boots and without pants... And all the worse, many people had gathered at the airport for meeting the cosmonauts... It was necessary to borrow someone's coveralls and a short jacket. Actually barefoot I made my way along the tarmac to the aircraft and climbed the ladder. Possibly I even offended the crowd: seeing some barefoot fellow wandering by at such a solemn moment...

The sensations, if you want to begin with walking, naturally changed. I was unsteady on my feet, just about the same as when you are walking on slippery ice; you have to watch your balance... The reaction to the controls is the same. Muscular sensations are somewhat lost; control skills are still good, but more concentration than usual is necessary in order to bring to bear the additional efforts applied to the controls and their movement. It became clear that such flights require truly well-developed skills. And the longer the absence from the earth,

the better prepared must be the flier. I understood why Young, for example, also trained in an aircraft for two hours prior to the "Shuttle" landing.

It was with such sensations that I flew a TU-154 to one of the airfields not far from Moscow. I landed, put on a high-altitude flight suit and took off in a MIG.

Interviewer: Alone?

Volk: No, to be sure, with an instructor. Back we went to Baykonur. We returned at two in the morning. It must be said that I was not the first to fly an aircraft after weightlessness. This had also been done by other cosmonauts earlier: Dzhaniyev, for example, and Popov... Only in my case the flight path when landing was a little steeper. Well, experience accumulates from flight to flight and serves everyone.

Interviewer: I heard that after this flight the very next morning you appeared on the tennis courts at Baykonur. The doctors were more than a little pleased. Possibly for this tennis "patriotism" you were elected chairman of the USSR Tennis Federation?

Volk: It was noticed by tennis players. Although that morning I probably did not control the racket, the racket probably controlled me. It was not to impress anyone. I simply wanted to "understand myself," to evaluate how quickly I could return to pre-space form, and thereby, return to a full workload. There was a sensation of impairment of coordination and muscular stress and it was necessary to recover as quickly as possible. However, for me it was simpler than for cosmonauts after long flights lasting almost a year...

Interviewer: We're interested in knowing when you got fully back in shape.

Volk: Judging from my subjective sensations, approximately three weeks after landing, while on leave, which we spent at Gagra... There the entire schedule was filled with activity: starting in the morning, the sports field, the sea, boating, walking; in the evening, concerts, the theater, playing the organ... Soon I was back in preflight shape. I understood that the time to get back to work had arrived.

Interviewer: Back to work... But now in a new status. Has something changed in your work as a test pilot? Are you now flying differently than before, or as a "simple flier?"

Volk: I exert my full energies, as before. Because this is my profession. It has become more difficult due to the social demands which accompany the title "cosmonaut." Regardless of this, it is necessary to maintain professional skills.

I ask permission to glance into the flight log of test pilot Volk. It appears that flight logs are rather thick volumes in which the flight history for all the years of work are

entered with an accuracy to a minute. The columns "permission for daytime flights under simple and difficult meteorological conditions" and "permission for nighttime flights under simple and difficult meteorological conditions" are peppered with the names of different aircraft, TU, IL, MIG, AN, SU and YaK, and a wide array of figures. After forcing the "author" to wrestle with the columns of figures, I get the following result as of today: almost 360 flight hours, about 640 sorties after space expeditions. Their character can be judged from brief entries, such as: "In spin." I ask whether this can be taken literally.

Volk: Literally, of course. Aircraft continue to be constructed and "live their lives" like people, encountering different situations. People are also interested in knowing how they behave in such situations. Let's say, an aircraft must come out of a spin and "does not want to"...

Interviewer: And you...

Volk: No, it "does not want" to come out of the spin in those seconds which are allocated. It can be brought out of the spin, let's say, in a minute.

Interviewer: And if it does not...

Volk: Anti-spin rockets, and finally, a special braking parachute can be used. But that point was not reached.

Interviewer: Igor Petrovich, I hope that the reusable ship is not afflicted by spin.

Volk: No. Although in the atmosphere it is an aircraft. Its flight is a joy for a large body of personnel after an enormous amount of work.

Interviewer: Now with respect to stereotypes, Igor Petrovich. A direct question. In your opinion does cosmonautics require restructuring? Or is it like "Caesar's wife"...

Volk: Restructuring, applying to all society, cannot exclude any of its manifestations. I am an ordinary citizen of our society and a rank- and-file worker in cosmonautics, and like any person I make my judgments and have my ideas which I would like to check out and advocate in direct and open professional discussion. It seems to me that the principal condition, now as never before, is the capacity for perceiving and interpreting reliable signals emanating from all sectors of our life. First of all, the information itself must be exceptionally precise. This applies to history, education, economics and engineering. Second, decisions must correspond to this accuracy, unclouded by the goals of fictitious well-being. This is the most complex problem in the psychology of interrelationships. This also requires personal courage and social democracy. And simply professionalism as well.

Project 'Radioastron'

*18660144 Moscow IZVESTIYA in Russian
10 Apr 88 p 2*

[Article by B. Konovalov: "Radio Telescope Larger Than the Planet"]

[Text] The attention of the international community is today a precise "barometer" of the value of a space project. It must be noted at once that the "Radioastron" project is evidently becoming a singular record setter with respect to the scales of international cooperation directed to its realization. A consortium of European radio observatories, the Technological University of Finland, the Australian Scientific Research Society, the Australian Radio Observatory and the United States National Radio Astronomical Observatory, in addition to our country, will directly develop the on-board equipment necessary for the space radio telescope and the means required for information processing. But it is still more important that all the largest radio telescopes in the world will work in "the same harness" with the space instrument. Four special centers, outfitted with the most powerful and high-speed computers, are being organized in Western Europe, Australia, the United States and in our country for the processing of the enormous flow of anticipated information.

The value of any telescope is determined by how faint a celestial source it can detect and how detailed the "picture" of the investigated object will be. For a long time the "Achilles heel" of radio telescopes remained their so-called angular resolution, the very ability to differentiate details of the observed "picture." This resolution is the better the shorter the wavelength used and the greater the diameter of the instrument. Since the length of the radio waves is hundreds of thousands of times greater than for visible light, the resolution of the radio telescopes was accordingly far less. There was only a single way to increase their "keenness of vision": an increase in the diameter of the receiving antennas. But, alas, the cost of the instrument increases proportionally to the cube of this diameter! Moreover, it is technically very difficult to make a parabolic dish with a diameter greater than 100 m. Accordingly, radio astronomy could not win in the traditional competition with optical astronomy.

But a way out was found: the interference method. This essentially involves the following: two widely separated receiving antennas are joined by a cable and simultaneous observations of radio sources are made. Such a system is equivalent to a continuous radio telescope and its resolution is determined by the distance between the antennas. Radio interferometers with a distance of several kilometers were constructed in the 1950's-1960's. Radio galaxies, for example, were discovered as a result. The next successive step was taken by the Soviet scientists N. Kardashev, L. Matveyenko and G. Sholomitskiy, who now work at the Space Research Institute, USSR Academy of Sciences. They proposed that the cables

connecting the antennas be dispensed with. By using modern magnetic recorders, precise time and distance services, the "marks" of reception of celestial radio pulses can be synchronized and then, using computers, scientific information can be extracted. Many pairs of radio telescopes located on different continents now operate on this principle. This has already made radio astronomy more "keen-eyed" than ordinary optical astronomy.

But the possibilities of our planet were exhausted. It is therefore proposed that a new jump be taken: put one of the radio telescopes into space at an adequately great distance. If it were to operate in unison with some terrestrial telescope, the resolution of such a system, in which one antenna moved and the other was fixed, would be determined by the maximum distance between them. It therefore becomes understandable why all the large radio observatories in the world expressed the desire to work in collaboration with the Soviet space radio telescope. Indeed, due to such cooperation their instruments would in actuality become equivalent to radio telescopes with a diameter greater than our entire planet.

The antenna of the space radio telescope in the "Radioastron" project is relatively small, having a diameter of 10 meters. But the satellite will move along an elongated elliptical orbit with an apogee of 80 000 km. This means that the possibilities of the pair of antennas of the "space-Earth" system will be approximately 10 times greater than for any surface complex located on different continents of the planet. According to computations, the resolution of the surface-space pair will be hundred-thousandths of a second of arc. This is thousands of times greater than for the world's largest surface optical telescope with a mirror diameter of 6 m, located in the Northern Caucasus.

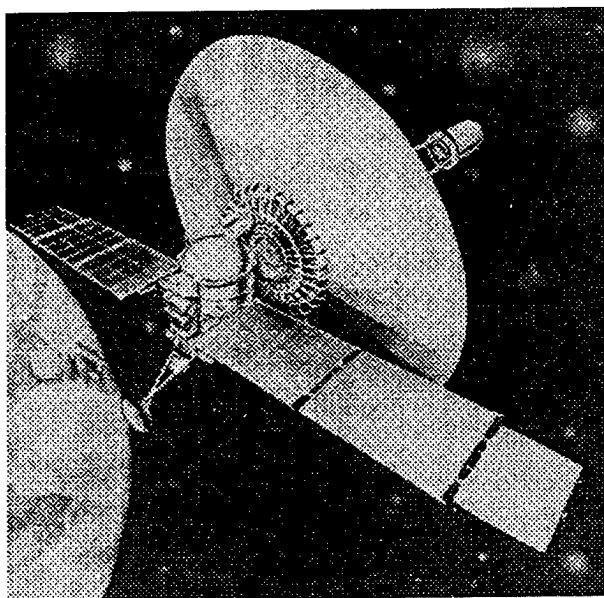
Moreover, a space radio telescope, operating in tandem with very large surface radio telescopes, will be hundreds of times more "keen-eyed" than the world's largest Hubble orbital optical telescope with a mirror diameter of 2.4 meters, now awaiting a launching which will occur after renewal of flight of the American space shuttles.

The technological preparations for constructing a space radio telescope cannot be completed in a single year. The operability of a space radio telescope with an antenna deployable in orbit was tested in 1979 during the flight of V. Lyakhov and V. Ryumin aboard the "Salyut-6," but it was not intended for radiointerferometric applications. Now the time is coming to take this step.

Usually already existing space vehicles are used for new projects. A special satellite weighing about 5 tons will be developed for the "Radioastron" project under the direction of V. Kovtunencko, corresponding member, USSR Academy of Sciences. The scientific apparatus will account for one and a half tons. The satellite should be put into an elongated elliptical orbit by means of a

powerful Soviet "Proton" rocket. The radio antenna itself should weigh 700 kg. It will be made from a new progressive material, carbon plastic. The world's best specialists are developing the sensitive receiving apparatus. The satellite will be supplied with a solar electric power station, a highly precise astronavigation system and an ultra-high-speed data transmission line.

The "Radioastron" will operate in tandem with the Soviet 70-m antennas of the Deep Space Communication System at Yevpatoriya and Ussuriysk. In addition, a special center of the Space Research Institute, USSR Academy of Sciences, is already being constructed in the mountains of Uzbekistan at a distance of 160 km from Samarkand on the Suffa Plateau. A 70-m parabolic antenna, communication facilities and a center for the processing of data arriving from the universe will also be constructed here.



The scientific director of the "Radioastron" project, Academician R. Sagdeyev, director of the Space Research Institute, USSR Academy of Sciences, and his deputy, N. Kardashev, corresponding member, USSR Academy of Sciences, have already dedicated themselves to this project for more than a decade. And even now they fear one thing: that some impediment will hold up realization of the project, which it is proposed be implemented in the early 1990's.

"Using the 'Radioastron'," says N. Kardashev, "it will be possible to investigate virtually all types of astronomical objects...we will be able to obtain a very great amount of new and unexpected information. There are many research possibilities. The most important are related primarily to extragalactic astronomy. We hope, for example, to make a detailed study of the processes transpiring near supermassive 'black holes,' in particular, to trace in detail the natural accelerator operating

near them which accelerates particles to energies which even in the distant future will not be attained by terrestrial accelerators. This is of interest not only to astronomers, but also to physicists who are studying the basis of structure of the microworld. Finally, it will be possible to ascertain with certainty the expansion constant of our universe, and this means, its age. This will make possible a better understanding of what transpired in the early stages of the initial 'big bang' in the part of the universe surrounding us. More careful measurements will evidently enable us to study the global properties of spacetime and to investigate latent forms of matter in the universe which for the time being cannot be detected.

"It is of great interest to investigate the center of our Galaxy, where a 'black hole' with a mass of about a million solar masses is evidently hidden. The 'Radioastron' will make possible a detailed study of pulsars, rapidly rotating neutron stars with an enormous magnetic field and very small 'black holes' with a mass of about one solar mass. Still another program will involve research on regions of new star formation and formation of planetary systems.

"It is important that the 'Radioastron' project is only the first step in a great future program. Even with those rocket systems which we have today we can put a space antenna tens, hundreds and thousands of times more distant and accordingly increase the 'keenness of vision' of a radio telescope by a corresponding factor.

"It can be expected that after the 'Radioastron' entire systems of many radio telescopes will appear in space, making it possible, with enormous accuracy, to investigate astronomical objects, to obtain their images and to ascertain coordinates. It will be possible to use direct methods for measuring distances to remote objects and to study their motion. The construction of such systems will evidently already become possible at the beginning of the next century."

5303

Operation of 'Astron' Observatory Spacecraft Said To Be Nearing End

18660168 Moscow PRAVDA in Russian 24 Mar 88 p 5

[TASS Report]

[Text] Nauchnyy (Crimea Oblast), 23 March. Soviet astronomers have been observing from space the supernova which flared up in the Large Magellanic Cloud. This was made possible by the astrophysical observatory "Astron", which was placed into a near-Earth orbit on 23 March 1983.

"In all probability, the 'Astron' is now 'taking its last look' at the supernova," said P. Petrov, deputy director of the USSR Academy of Sciences' Crimean Astrophysical Observatory. "It appears that it will soon complete its term of excellent service, which has been five times as long as we calculated it to be. During this time, 585 periods of communications have been conducted with the spacecraft, and information has been gathered on distant stars and gaseous nebulas. It has been possible, for example, to record rapid flare-ups of stars which last for only seconds. An unusually high content of heavy metals was detected in the atmospheres of certain stars, which sheds new light on the origin of chemical elements. Observations were made of Halley's, Bradfield's and other comets."

FTD/SNAP

/9738

TASS Update on Flight of 'Cosmos-1870' Satellite
18660169 Moscow PRAVDA in Russian 26 Jan 88 p 6

[TASS Report]

[Text] Flight Control Center, 25 January. The flight of the artificial Earth satellite "Cosmos-1870", which was placed into a near-Earth orbit on 25 July 1987, is continuing.

During the past six months, radar scanning of the territory of the Soviet Union and individual areas of the waters of the world's oceans has been conducted regularly, and flows of charged particles in near-Earth space have been studied, in line with the designated program of work.

Television equipment intended for taking pictures of the Earth's surface is now being tested and readied for operation, on commands from the Earth.

Scientific information obtained with the aid of the "Cosmos-1870" satellite is being transmitted to the state scientific research and production center "Priroda" of the USSR Main Administration for Geodesy and Cartography for study and use in various branches of science and the economy.

FTD/SNAP

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Soviet-Polish Ionosphere Research With 'Cosmos-1809' Satellite Completed

18660117 Leningrad LENINGRADSKAYA PRAVDA in Russian 3 Feb 88 p 3

[TASS Report]

[Text] Warsaw, 2 February. A Soviet-Polish space experiment, "Ionozond-2", has been successfully completed. This experiment was conducted with the aid of the artificial Earth satellite "Cosmos-1809." This spacecraft, which was placed into a near-Earth orbit in December of 1986, is intended for conducting geophysical research in the ionosphere. Polish equipment installed on the satellite recorded phenomena in the ionosphere during the past year.

In collaboration with Soviet colleagues, scientists of the Polish Academy of Sciences' Space Research Center have now begun processing data obtained during the experiment in orbit. The initial results already indicate that a considerable amount of interesting information was obtained, particularly in regard to wave propagation in the upper layers of the atmosphere, effects which radio transmitters on the ground produce on the ionosphere, and the nature of electromagnetic interference.

The Soviet and Polish specialists have focused special attention on studying the physical nature of such phenomena as the appearance in the ionosphere of electromagnetic interference caused by the flight of artificial Earth satellites.

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Observation of Gamma Bursts on 'Prognoz-9' Artificial Earth Satellite

18660139 Moscow PISMA V ASTRONOMICHESKIY ZHURNAL in Russian Vol 14, No 3, Mar 88 (manuscript received 3 Jul 87) pp 216)223

[Article by M. I. Kudryavtsev and S. I. Svertilov, Moscow State University]

[Abstract] Despite extensive research, the sources of gamma bursts remain unknown, although most researchers support the idea of a galactic origin of such bursts. The study of statistical patterns is one of the promising directions in research on gamma bursts. By comparing the distribution of the sources of gamma bursts in the celestial sphere and their amplitude distribution light can be shed on whether the sources of gamma bursts are identifiable with certain astrophysical objects. Such research on the statistical characteristics of gamma bursts was one of the objectives of the X-ray experiment carried out by the Scientific Research Institute of Nuclear Physics on the "Prognoz-9" artificial earth

satellite. Distance of the satellite from the Earth at apogee was about 700 000 km. From time to time (each 5 to 7 days) the satellite was oriented in the direction of the sun. This satellite carried an instrument for the registry of X-radiation and detectors of high-energy charged particles (protons and electrons). The X-ray instrument was a scintillation spectrometer operating in the range of photon energies from 10 to 200 keV; its axis coincided with the axis of satellite rotation. In the course of the experiment observations were made of an extensive region of the star sky adjacent to the ecliptic, including the region of the center of the Galaxy and galactic anticenter, and also regions far from the galactic equator. During the experiment about 1000 increases in counting rate were registered; 15 events were identified as gamma bursts and these, with their pertinent parameters, are listed in a table. The absence of an increase in the frequency of registry of gamma bursts during observation of the center of the Galaxy and regions adjacent to the galactic equator is consistent with earlier findings of an isotropic distribution of sources of gamma bursts in the celestial sphere. Since in this experiment the identification of bursts was based on detector readings in the energy interval from 25 to 50 keV, there was an evident spectral selection relative to hard events. Further research is required to clarify the role of time and spectral selection in such identifications. Figures 3; references 25: 11 Russian, 14 Western. 5303

521.1+530.12:531.51

Relativistic Effects in Motion and Observations of Artificial Earth Satellites. I. Relativistic Perturbations in Satellite Motion

18660140 Leningrad VESTNIK LENINGRADSKOGO UNIVERSITETA: MATEMATIKA, MEKHANIKA, ASTRONOMIYA in Russian No 1, Jan 88 (manuscript received 5 Feb 87) pp 84-91

[Article by A. V. Krivov, Leningrad University]

[Abstract] The increasing demands on accuracy in satellite observations dictate that relativistic effects be fully taken into account. Although their influence is relatively small, their computation is much more difficult than for many traditional factors. Relativity theory requires a reexamination of certain customary concepts and algorithms (V. A. Brumberg has made the greatest contributions along these lines). A scheme is proposed in which the motion of points (the objects of observations), motion of observer points and motion of photons between objects and observers are computed on the basis of relativistic laws in an arbitrary coordinate system. The parameters which are obtained are dependent on the adopted coordinate system and therefore cannot be compared with observations. A comparison can be made by a relativistic reduction of coordinate-dependent parameters. The intervals of coordinate time must be scaled to the proper time of the observer. The vectors of coordinate velocity of photons from two sources are used in writing an expression for the proper angle between the directions to these sources. In

this stage allowance is also made for special relativistic effects describing the influence of the observer's velocity on the measurement results and general relativistic effects reflecting the dependence of measurement results on the gravity field at the observation point (such as the gravitational frequency shift and the gravitational slowing of time). Applicable to satellite problems the proposed scheme requires computation of the coordinates of an artificial earth satellite with allowance for relativistic perturbations (formulation of a relativistic theory of AES motion); computation of coordinates of the observation station with allowance for relativistic "deformation" of the Earth and relativistic effects in its rotation; computation of photon motion; modeling of measurement procedures (laser sounding, Doppler observations, radiointerferometry, position measurements). Different variants of application of this scheme are analyzed; barycentric and geocentric approaches are examined in detail. This study differs from earlier investigations by the inclusion of terms related to rotation of the Earth and Sun. The equations of motion for an AES which include the main relativistic perturbations are derived. These relativistic perturbations represent only one kind of the relativistic effects involved. The others will be examined in a future paper. References 23; 12 Russian, 11 Western.

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523.6

Mechanism of Interaction Between Halley's Comet and Zodiacal Dust Cloud Deduced From Spacecraft Data

18660141j Moscow KOSMICHESKIYE ISSLEDOVANIYA in Russian Vol 26 No 1, Jan-Feb 88 (manuscript received 19 Aug 87) pp 63-67

[Article by S. Ibadov]

[Abstract] A study was made of the interaction between the gas-dust comas of comets and dust particles of the Zodiacal cloud. Both the meteorlike and explosive mechanisms are examined. The meteorlike process is associated with evaporation in the meteor zone of the comet with a predominant part of the Zodiacal dust particles containing particles with masses less than 10^{-8} g. A test to ascertain the dominant role of one of these mechanisms in the atmosphere of a specific comet was found by a comparison of the effective radii of the detected mechanisms. Use of the results of scientific experiments carried out by the "Vega" and "Giotto" space vehicles indicates that in the atmospheres of dust comets of the Halley type the explosive mechanism is the most important. Under such conditions not only is the generation of atoms of metals possible, but also X-radiation and multiply charged ions of elements such as Fe, Si, C, O and others as a result of the formation of hot plasma

blobs during collisions of cometary and Zodiacal dust particles with great (more than 70 km/s) relative velocities. References 22: 5 Russian, 17 Western.

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550.370

**Solar Wind Mass Loading at Halley's Comet:
Lessons For Venus**

18660141k Moscow KOSMICHESKIYE
ISSLEDOVANIYA in Russian Vol 26 No 1, Jan-Feb 88
(manuscript received 19 Mar 87) pp 68-76

[Article by T. K. Kreus, A. M. Krymskiy and J. G. Luhmann]

[Abstract] Direct investigations of interactions between Halley's Comet and the solar wind revealed that near the comet there is a region of magnetized cometary plasma which had not been observed earlier experimentally and whose existence had not been predicted in most theoretical studies. However, such a region has similarities to the region of magnetized planetary plasma observed in the Venusian daytime atmosphere under conditions when the dynamic pressure of the oncoming solar wind flow exceeds the maximal pressure of ionospheric plasma. Although the details of these phenomena for Venus and Halley's Comet are different, the penetration of the magnetic field through the ionopause on Venus and through the cometopause on Halley's Comet is evidently a result of similar charge exchange and photoionization processes. In the case of Venus this effect is manifested when, under the influence of high dynamic pressure of the solar wind, the degree of its loading by ions of planetary origin becomes comparable to the cometary load. Figures 3; references 32: 4 Russian, 28 Western.

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629.197:523.6

**Statistical Algorithm for Guidance of 'Vega'
Spacecraft Platform to Halley's Comet**

18660141l Moscow KOSMICHESKIYE
ISSLEDOVANIYA in Russian Vol 26 No 1, Jan-Feb 88
(manuscript received 11 Mar 87) pp 77-87

[Article by Yu. A. Bozhor, O. V. Papkov, K. G. Sukhanov and V. N. Kheyfets]

[Abstract] The "Vega" spacecraft carried a television system, infrared and three-channel spectrometers mounted on a rotating platform (ASP-G) which upon encountering Halley's Comet should track its center. This article describes the principles applied in writing an algorithm for guiding the ASP-G. The guidance system is illustrated in a block diagram. Information from the television system, by means of statistical filtering, is used in continuous refinement of the parameters determining

the relative motion of the spacecraft and comet. These parameters include the constants describing deviations of the vehicle axes from an inertial reference system and constants describing the relative motion of the centers of mass of the comet and spacecraft; the refined values of the parameters are computed for predicting relative motion on the basis of angles and angular velocities (a program for ASP-G guidance is described). The principal advantages of such an approach are: a guidance program is constantly being formulated on the spacecraft for the entire remaining part of the tracking period and this can be used in the event of a temporary or complete loss of information; all information is used in preparing the program (there is no loss of useful signals); algorithm stability against losses of measurement data is ensured (up to 30-50

information loss is admissible); all systematic guidance errors can be compensated for. The algorithm is described in detail. The actual use of the described algorithm was highly successful. Figures 5.

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629.197:523.6

**Growth Curves of Emission Lines in Cometary
Spectra and Determination of Water Vapor and
Hydroxyl Production in Halley's Comet**

18660141m Moscow KOSMICHESKIYE
ISSLEDOVANIYA in Russian Vol 26 No 1, Jan-Feb 88
(manuscript received 15 Oct 86) pp 88-95

[Article by V. A. Krasnopolskiy and A. Yu. Tkachuk]

[Abstract] The growth curve for emission lines in cometary spectra is dependent on a process determining line broadening (in this case, the Doppler effect). In computing the growth curve it is necessary to stipulate the distribution of concentrations and velocities at different points in a comet. Since the computation process is rather unwieldy, use was made of a simplified model of the distribution of the concentrations of matter in the coma with an isotropic escape with a velocity v_0 relative to the cometary nucleus. The geometry of the computations is described in detail. Formulas are derived for primary and secondary molecules and families of growth curves were constructed with variation of one parameter or another. This approach was used for determining water vapor production in Halley's Comet at a heliocentric distance 0.8 a.u. on the basis of the results of measurements of the H₂O bands 2.7 and 1.38 μ on the "Vega" spacecraft; these were equal to 1.1×10^{30} and $0.8 \times 10^{30} \text{ s}^{-1}$ respectively. The formulas for secondary molecules applicable to measurements of the OH 3090 A band in Halley's Comet on the IUE satellite, with allowance for band structure, give a hydroxyl production 0.9 plus or minus $0.25 \times 10^{30} \text{ s}^{-1}$. A close value was obtained by mass spectrometer measurements on "Giotto" at a distance of 0.9 a.u. (In a comparison of such data it is

necessary to take into account not only changes in heliocentric distance, but also strong variability of gas release by Halley's Comet.) Figures 5; references 12: 2 Russian, 10 Western.

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523.72

Region of Formation of Nucleus of Halley's Comet and Some Processes in Preplanetary Nebula

18660141n Moscow KOSMICHESKIYE
ISSLEDOVANIYA in Russian Vol 26 No 1, Jan-Feb 88
(manuscript received 28 Aug 86) pp 96-102

[Article by M. N. Izakov]

[Abstract] There are two alternative hypotheses on the formation of cometary nuclei: they arose in a gas-dust preplanetary nebula forming around the sun simultaneously with it or they were formed in interstellar clouds. In this article it is demonstrated that observational data indicate that the nucleus of Halley's Comet was formed in the preplanetary nebula and the formation of such cometary nuclei is an inevitable consequence of dynamic processes within it. Both "Vega" and "Giotto" measurements demonstrated that most cometary dust particles are similar in composition to carbon chondrites, whereas 30 percent of these particles have a completely different composition. It can be postulated that the first of these are interstellar dust particles which survived upon entry into the preplanetary cloud, whereas the others were formed from matter thermally transformed near the sun and then transported to the periphery of the preplanetary nebula. Comparison of data on the nucleus of Halley's Comet with findings on the early history of the solar system suggest that this nucleus was formed in the preplanetary nebula near the nuclei of Uranus, Saturn or possibly Neptune. Figures 2; references 33: 25 Russian, 8 Western.

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Place of Halley's Comet in General Scheme of Origin of Comets

18660141o Moscow KOSMICHESKIYE
ISSLEDOVANIYA in Russian Vol 26 No 1, Jan-Feb 88
(manuscript received 13 Oct 87) pp 103-115

[Article by V. D. Davydov]

[Abstract] An attempt was made to explain data on the figure of the nucleus of Halley's Comet on the basis of photographs from flyby space vehicles in 1986. The Arachis-like nucleus could be formed from a former system of two bodies under definite conditions. A preliminary analysis of this hypothesis was carried out. A

means was found for solving the problem of the quantitative characteristics of collision and destruction. Quantitative estimates confirm the possibility of retention of the initial form of two "space icebergs" after their joining in a relative velocity range up to several meters per second. Then a complex is formed with an appreciable saddle between the two merging fragments. The proposed hypothesis fits in well with the general scheme of origin of comets with different types of nucleus (V. D. Davydov, KOSMICH. ISSLED., Vol 23, No 5, p 766, 1985). Using the general scheme it is possible to obtain highly important details for this hypothesis. It can be postulated that the reason for the joining of the two bodies might be destabilization of the system, for example, due to a burst of tidal force. The two joining bodies did not experience total destruction. The size of the forming complex makes it possible to estimate the velocity of Keplerian motion in the former system of two bodies, and therefore, the initial velocity of collision. An attempt was made to find the characteristics of destruction as a function of the strength of matter. Quantitative estimates revealed the conditions under which the retention of a considerable part of the initial figure of each of the two joining bodies was possible. The hypothesis makes it clear why Halley's Comet became an especially active body. After its arrival in the zone of planetary orbits from the Oort Cloud, during its passage near one of the large planets its orbit was transformed into a periodic orbit. References 15; 7 Russian, 8 Western.

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550.385:550.385.41

Radiation Conditions in Geostationary Orbit for Magnetically Quiet Conditions Determined Using Data From 'Raduga' Communication Satellites

18660141p Moscow KOSMICHESKIYE
ISSLEDOVANIYA in Russian Vol 26 No 1, Jan-Feb 88
(manuscript received 18 Jun 85) pp 120-126

[Article by Yu. N. Vakulin, O. S. Grafodatskiy, V. I. Degtyarev, V. I. Dovgiy, G. A. Zherebtsov, Sh. N. Islyayev, V. N. Kanaleyev, A. G. Kozlov, G. M. Marke-
lov, O. P. Platonov, G. V. Popov, M. I. Panasyuk and E. N. Sosnovets]

[Abstract] The results of measurements of high-energy protons and electrons of auroral energies on the "Raduga" geostationary communication satellites during the period 1978-1981 are presented. Proton fluxes were measured in the energy range 270 keV-5 Mev and differential fluxes of low-energy (0.3-5 keV) electrons were measured in geostationary orbit under quiet geophysical conditions characterized by a magnetic activity index equal to or less than 1. The results make possible a more precise determination of the structure of the outer boundaries of the radiation belts and can be

used for predicting radiation conditions in geostationary orbit under magnetically quiet conditions. It is concluded that peculiarities in the spatial distribution of low-energy electrons along the orbit of a geostationary satellite are attributable to isolated magnetic disturbances of the substorm type. The collected information made possible a considerable supplementation of the results of research carried out under other geophysical conditions. An expression is derived which approximates the quiet diurnal variation of energetic protons and which can be used in predicting radiation conditions in a geostationary orbit under magnetically quiet conditions. The distribution of low-energy electrons along a geostationary orbit under conditions of low magnetic disturbance is quite stable in different longitude sectors and the periodically observed peculiarities in the spatial distribution of the flux density of these electrons are attributable to their injection into the region of geostationary orbits during local geomagnetic disturbances. Figures 2; references 11: 7 Russian, 4 Western.

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Research on Electric Field Strength in Rarefied Plasma

18660141r Moscow KOSMICHESKIYE
ISSLEDOVANIYA in Russian Vol 26 No 1, Jan-Feb 88
(manuscript received 10 Mar 87) pp 152-154

[Article by V. Ye. Korepanov]

[Abstract] The combined wave diagnostics method, successfully used on a number of satellites and space probes, was developed for experimental confirmation of the theory of collisionless shock waves in rarefied plasma. This method involves simultaneous measurements of electric field strength, plasma flows and magnetic induction and with great certainty makes it possible to identify types of instabilities and to study the stages in their development. However, measurement of electric field strength in rarefied plasma is very difficult. The reliability of the method has been demonstrated when the length of the measurement base between the electric probes is much greater than the Debye radius, but in some cases this condition has not been satisfied (the base must be shorter) and both probes fall within one screening layer whose conductivity is less than the conductivity of undisturbed plasma. This layer is a local inhomogeneity within which the electrical field strength E_i differs from the strength of the undistorted field in the medium E_0 . The deviations between E_i and E_0 are examined in detail. It is shown that when measuring electric field strength in interplanetary space an exaggerated result is always obtained when a short base is used (it may exceed the true value by a factor of 1.5). Figure 1; references 10: 7 Russian, 3 Western.

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629.785

Autonomous Navigation of Stationary Artificial Earth Satellite Using Measurements With Low Information Yield

18660141s Moscow KOSMICHESKIYE
ISSLEDOVANIYA in Russian Vol 26 No 1, Jan-Feb 88
(manuscript received 25 Feb 86) pp 154-157

[Article by A. P. Kamyshanov, V. I. Karlov and M. N. Krasilshchikov]

[Abstract] The problem of autonomous navigation of artificial satellites in a geosynchronous orbit is difficult because only astronomical measurements can be used in determining the parameters of motion and measurements are accompanied by considerable systematic errors. Therefore, in order to ensure the required navigational accuracy it is necessary to process hundreds of measurements. There has been a distinct need for a fast mathematical model of satellite motion which would ensure a high accuracy, taking into account restrictions on computer speed and memory volume and other factors. A solution of this problem is proposed in which due to choice of an effective coordinate system, use of analytical formulas for near-circular motion, a recurrent evaluation algorithm and optimization of the strategy for measurements of navigational parameters it was possible to overcome these difficulties and develop a fast algorithm ensuring a high accuracy in autonomous navigation. The problem is solved in a rotating orbital spherical coordinate system referenced to the mean elements of perturbations of the satellite orbit. It is also shown that a considerable increase in the accuracy of autonomous navigation can be achieved by the optimal planning of measurements. This involves optimal positioning of the navigational radio contacts (with a duration of 1 hour) in the navigation interval. In solving this problem it was assumed that the satellite does not enter Earth's shadow and the approach used was that described by A. I. Zverev, et al. in IZV. AN SSSR: TEKHN. KIBERNETIKA, No 4, 1984. Figure 1; references: 5 Russian.

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517.11:531.382

Kinematic Variables in Equations of Motion for Solid Body in Atmosphere

18660141t Moscow KOSMICHESKIYE
ISSLEDOVANIYA in Russian Vol 26 No 1, Jan-Feb 88
(manuscript received 1 Apr 86) pp 157-159

[Article by G. M. Lokhov and S. I. Podzorov]

[Abstract] Comparison and choice of kinematic variables in the equations of motion is an important task in constructing an effective mathematical model of motion of a solid body in the atmosphere. Euler angles, direction cosines or Rodrigues-Hamilton parameters in the form of quaternions have been traditionally used as the kinematic variables describing orientation of a body relative

to an inertial coordinate system. A comparative study was made of these three systems of kinematic variables relative to the model problem of regular precession and the real problem of spacecraft descent in the atmosphere. Joint numerical integration of the kinematic and dynamic equations of motion was by the Runge-Kutta method. In the model problem a study was made of regular precession of an elongated solid body with stipulated parameters. A precise solution in this model problem, integrable with a constant interval in a time interval of 60 s, makes it possible to evaluate the behavior of the error as a function of time. In general, the use of quaternions or Euler angles is equally effective. A study of spacecraft descent into the atmosphere was made to ascertain the influence of the integration interval on the error in numerical solution for all three systems of kinematic variables. It was found that the best choice in this case is the use of quaternions. Figure 1; references: 3 Russian.

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550.388.2

Gradient-Drift Instability in Artificial Ionospheric Disturbances

18660141u Moscow KOSMICESKIYE
ISSLEDOVANIYA in Russian Vol 26 No 1, Jan-Feb 88
(manuscript received 3 Jul 86) pp 159-161

[Article by V. B. Ivanov, M. A. Koyen and S. A. Rudykh]

[Abstract] Artificial ionospheric inhomogeneities, whose characteristic dimensions are tens of kilometers, have steep gradients of plasma concentration. Under these conditions, even with the presence only of natural electrical fields caused by the dynamo mechanism, there can be effective development of gradient-drift instability, resulting in formation of a small-scale inhomogeneous structure of the disturbances. The analysis of plasma instability is difficult under these conditions (an analysis based on solution of the local dispersion equation is inapplicable). However, an equation can be derived for the dynamics of development of small initial disturbances which describes disturbances with parameters satisfying the conditions for a hydrodynamic collisional description of plasma. Computations were made of the instability increment and the eigenfunctions for the injection of a plasma cloud with stipulated parameters into the middle-latitude ionosphere at nighttime. It was found that instability develops most effectively on the cloud periphery at a considerable distance from the disturbance center. The inhomogeneities described by four eigenfunctions increase with time. The time for the development of inhomogeneities varies in the range from 100 to 1000 s. It is shown that the use of eigenfunctions makes it possible to analyze the anticipated nature of the inhomogeneous structure of artificial plasma formations in the ionosphere. The instability which appears generates inhomogeneities with transverse scales of

about a kilometer and longitudinal dimensions comparable to the longitudinal dimensions of the artificial formations themselves. These findings are useful in interpreting the processes of formation of irregularities of plasma clouds injected into the ionosphere or "ionospheric holes" forming during spacecraft launchings. Figure 1; reference: 1 Russian.

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Anticipated X-Radiation From Supernova 1987A. Analytical Examination

18660128a Moscow PISMA V ASTRONOMICHESKIY
ZHURNAL in Russian Vol 13 No 12, Dec 87
(manuscript received 1 Sep 87) pp 1042-1054

[Article by S. A. Grebenev and R. A. Syunyayev, Space Research Institute, USSR Academy of Sciences, Moscow]

[Abstract] The flare of the supernova 1987A in the Large Magellanic Cloud renewed interest in the comptonization of high-frequency radiation in a cloud of cold plasma optically thick for Thomson scattering. A study was made of three possible sources of hard photons in the central part of the cloud: decay of radioactive ^{56}Co , accompanied by emission of gamma quanta with energies from 511 keV to 3.2 MeV, radiation of a young pulsar similar to the pulsar in the Crab Nebula but possibly having a lesser period and a harder spectrum, and hard radiation of cosmic rays accelerated by a young pulsar in the inner cavity of the envelope. Each of these possibilities was considered. A solution was obtained within the framework of a diffusional approximation (in space) and a Fokker-Planck approximation (with respect to photon energies) in the form of a rapidly converging series describing the spectrum of $h\nu$ 1 MeV radiation emerging from the supernova envelope, regardless of the nature of the central source of hard photons. It was found that the principal processes determining the form of the spectrum is Compton scattering on cold electrons, accompanied by a recoil effect, and photoabsorption. A procedure is described which makes it possible to determine envelope geometry in the course of observation of directly emitted γ quanta. The main result of this research is an analytical solution of the problem (formulas 11 and 15), obtained in a Fokker-Planck approximation, and giving surprisingly good agreement with the results of numerical computations in the energy region $h\nu$ 200 keV of photons emanating from the envelope (with the initial energy of photons playing virtually no role). Figures 5; references 11: 6 Russian, 5 Western.

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Analysis of Time Structure of Powerful Gamma Burst GRB 830801

18660128b Moscow PISMA V ASTRONOMICHESKIY ZHURNAL in Russian Vol 13 No 12, Dec 87 (manuscript received 31 Mar 87) pp 1055-1060

[Article by A. V. Kuznetsov, R. A. Syunyayev, O. V. Terekhov, M. Boyer, G. Vedrenne, M. Niel and K. Hurley, Space Research Institute, USSR Academy of Sciences, Moscow; Cosmic Radiation Research Center, Toulouse, France]

[Abstract] One of the most important results of the Soviet-French experiment SNEG-2MP9 was observation of the gamma burst GRB 830801, one of the most powerful bursts of this type ever observed. The time evolution of events in different energy channels is discussed. The mean energy of photons in 4 seconds decreased from 600 to 150 keV and then changed slightly to the end of the burst. A search for a period in the time structure of the gamma burst is possible due to the high flux and smooth time structure. Data were analyzed in the energy range $E = 68-930$ keV. The Fourier power spectrum was constructed in the frequency interval from 1 to 32 Hz. The upper limit for the pulsating component did not exceed 3-4

of the total flux of photons registered by the instrument. This means the absence (in the investigated frequency range) of regular pulsations and phenomena observed in quasiperiodic objects. However, an analysis revealed the presence of a quasiperiod of 5.9 s, visible on the burst brightness curve. The existence of a quasiperiodic component is not an adequate basis for drawing conclusions concerning the nature of this source, as was possible in the case of the gamma burst of 5 March 1979 for which the presence of an 8-second periodicity in the experimental data was unquestionable and served as a basis for its classification as an X-ray pulsar. Figures 4; references 5: 3 Russian, 2 Western.

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Hydroxyl Observations in Halley's Comet

18660128c Moscow PISMA V ASTRONOMICHESKIY ZHURNAL in Russian Vol 13 No 12, Dec 87 (manuscript received 28 Jul 86, after revision 20 Apr 87) pp 1100-1103

[Article by N. V. Bystrova, G. S. Golubchin, I. V. Gosachinskiy, A. S. Morozov, Ye. K. Nizhelskaya and N. A. Yudayeva, Leningrad Affiliate, Special Astrophysical Observatory, USSR Academy of Sciences]

[Abstract] The hydroxyl line in Halley's Comet at a frequency of 1667 MHz was observed in November-December 1985 and in March 1986 with the northern sector of the RATAN-600 radio telescope (width of antenna directional diagram at 18 cm— $1.8 \times 110'$,

effective area—about 800 m², system noise temperature—about 80 K). A 39-channel filter spectrum analyzer with a channel width 30 kHz (5.5 km/s) was used. The time constants of the spectrometer output elements were 6 s. Overall control of the radio spectrometer and registry of measurements on magnetic tape was with a "Mera 60" computer. The antenna setting and spectrum analyzer tuning were based on ephemerides of Halley's Comet computed at the Theoretical Astronomy Institute for the times of its culmination on the RATAN-600. The observation results are represented in 3 figures: Fig. 1 (comet); Fig. 2 (comparison region); Fig. 3 (reference sources). The profiles in Fig. 1 show details in absorption and emission, whose parameters (radial velocity of a detail relative to the ephemeridal velocity of the comet, antenna temperature and the corresponding flux quantities in the diagram) are given in Table 2. A surprising finding was the great radial velocities at which details in the OH spectra from Halley's comet were discovered because such velocities have never been observed in other comets. Any discussion of the physical nature of this unusual emission of the OH line would be premature since its existence must be confirmed by the results of observations made during this same period at other observatories. Figures 3.

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528.225 - 629.783

Adaptive Model of Upper Atmosphere

18660138a Moscow IZVESTIYA VYSSHIKH UCHEBNIKH ZAVEDENIY: GEODEZIYA I AEROFOTOSYEMKA in Russian No 5, Sep-Oct 87 (manuscript received 17 Mar 87) pp 63-69

[Article by V. A. Lupovka, graduate student, and Yu. M. Manakov, docent, candidate of technical sciences, Moscow Order of Lenin Institute of Geodetic, Aerial Mapping and Cartographic Engineers]

[Abstract] The accuracy of presently available atmospheric models does not make it possible to take into account the influence of atmospheric braking on the motion of artificial earth satellites (AES) with an accuracy corresponding to the present-day accuracy of trajectory measurements. When there is a need for highly precise prediction of the motion of AES, allowance for atmospheric braking is possible by use of an adaptive model whose coefficients are periodically made more precise, taking into account the real state of the atmosphere on the basis of highly precise trajectory measurements or data from special atmospheric satellites. The proposed model is based on the representation of atmospheric density by multidimensional Chebyshev interpolation forms whose coefficients are periodically made more precise using data on AES braking. The structure and principles of construction of local and global variants of the model are described. Expressions for the required Chebyshev polynomials are given through satellite orbital elements for a relative accuracy of the

model of about 1 percent. The model can be used for both numerical and analytical integration of AES equations of motion. The principle on which the adaptive model is based will make it possible to increase the accuracy in predicting AES braking in comparison with existing atmospheric models due to allowance for the real density distribution. References 10: 6 Russian, 4 Western.

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528.77:528.711.1(202)

Method for Instrumental Interpretation of Space Scanner Survey Materials on Earth's Cloud Cover

18660130b Moscow IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY; GEODEZIYA I AEROFOTOSYEMKA in Russian No 5, Sep-Oct 87 (manuscript received 9 Apr 87) pp 95-98

[Article by A. I. Sharov, graduate student, Moscow Order of Lenin Institute of Geodetic, Aerial Mapping and Cartographic Engineers]

[Abstract] A method has been developed for instrumental interpretation of materials from a space scanner meteorological survey. It is shown that it is feasible to use synthesizing instruments of the MSP-4 type for processing bispectral space images of the earth's cloud cover at regional stations for the reception of satellite data, such as from the "Meteor" and "NOAA" satellites. On the side of the earth illuminated by the sun the survey is made in the wavelength range 0.725 to 1.0 μm , and on the nighttime side in the ranges 3.63 to 3.93 and 10.5 to 11.5 μm . (A block diagram of the process of reception and processing of such bispectral data is given.) The procedures for masking the processed images for the purpose of detecting structural features of cloud formations is described. The admissible size of the images which can be processed is 70 x 90 mm; the maximum duration of presence of a meteorological satellite in the zone of radio visibility of the receiving station antenna is 15 minutes, a factor important in the processing procedure. Chemical photographic processing is followed by time and geographical referencing of the material and preparation of photo prints. An enlarged color image is formed on the MSP-4 screen and the interpretation results are sent for photo printing. Use of the proposed method increases the reliability and detail of cloud cover classification, especially in the case of multilayer clouds, makes it possible to determine the nature of cloud distribution by levels and roughly estimate the moisture reserve in any cloud formation. There is also an increase in the reliability of interpretation of cloud formations against the background of an underlying surface close in its optical or radiation characteristics to the cloud cover. Figure 1; references: 2 Russian.

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Interpreting Burst Spectra From X-Ray Burster MXB 1728-34 With Allowance for Thomson Scattering

18660131a Moscow PISMA V ASTRONOMICHSKIY ZHURNAL in Russian Vol 14 No 1, Jan 88 (manuscript received 2 Jun 87) pp 37-48

[Article by A. D. Kaminker, G. G. Pavlov, Yu. A. Shibyanov, V. G. Kurt, A. S. Smirnov, V. M. Shamolin, I. F. Kopayeva and Ye. K. Sheffer, Physical Technical Institute imeni A. F. Ioffe, USSR Academy of Sciences, Leningrad; Space Research Institute, USSR Academy of Sciences, Moscow; State Astronomical Institute imeni P. K. Shternberg, Moscow]

[Abstract] It has been postulated that bursts of X-ray bursters occur primarily as a result of the explosive thermonuclear combustion of matter accumulating on the surface of neutron stars undergoing accretion in close binaries and that the emission of the photospheres of flaring envelopes is black body type. However, it is now clear that the burster emission spectrum should differ from a Planck spectrum (the emission spectra of neutron stars obtained with allowance for electron scattering must be used instead). A. D. Kaminker, et al. (ASTRON. ZHURN., 1988, in press) has proposed use of an analytical solution of the problem of radiation transfer obtained by Ya. B. Zeldovich and N. I. Shakura (ASTRON. ZHURN., Vol 46, 1969) for an isothermic scattering photosphere, also taking into account radiation pressure and general relativity effects. The Kaminker method is applied in the present article for analysis of a burst of the typical burster MXB 1728-34 registered on 28 April 1983 by the ASTRON automatic station. Information on observations, analysis and interpretation were given earlier by A. D. Kaminker, et al. (Preprint FTI, No 1133, 1987) and therefore only the main results are given here. It is shown that if it is assumed that the spectra near the burst maximum are formed in the isothermic photosphere of a neutron star with a predominant role played by Thomson scattering, reasonable limits can be obtained for the mass and radius of a neutron star and the distance to the object and it can be concluded that the photosphere expands to several tens of kilometers at the burst maximum. In the course of expansion and subsequent compression the luminosity is close to Eddington. Due to general relativity effects the maximum of the observable flux corresponds to the luminosity minimum. The spectra in the tail of the burst are close to the bremsstrahlung spectra of optically thin warm plasma. Analysis of another such burst, MXB 1728-34, also registered by ASTRON, disclosed a similar spectral evolution and parameters close to those obtained for MXB 1728-34. Figures 6; references 23: 7 Russian, 16 Western.

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523.64

Nature of Internal Energy Source in Nucleus of Halley's Comet

18660131b Moscow PISMA V ASTRONOMICHSKIY ZHURNAL in Russian Vol 14 No 1, Jan 88 (manuscript received 22 Jun 87) pp 85-90

[Article by E. M. Drobyshevskiy, Physical Technical Institute imeni A. F. Ioffe, USSR Academy of Sciences, Leningrad]

[Abstract] The totality of the results of cometary missions has refuted sublimation models of cometary phenomena in which solar radiation has been regarded as the sole energy source. This is made clear by the systematic excess of the velocity and temperature of the gas escaping from the nucleus over the theoretical values, the concentration of emission in about 10 narrow hypersonic jets which transport a very great quantity of CHON dust, intense production of CO, together with a lesser quantity of CO₂, and great near-nucleus abundances of

C and C⁺. Newly collected facts, together with some old facts which are not clearly understood, such as great C₃ quantities in the coma, can explain combustion in sublimation products if the ice in the nucleus contains not only hydrocarbons and substances containing nitrogen, but also free oxygen (about 15 percent by mass). The presence of oxygen in cometary ice is part of the new eruptive concept in which it is postulated that small bodies originated as a result of explosions of the massive ice envelopes of distant moonlike bodies of the Ganymede type saturated with electrolysis products. This concept was developed by the author of this article in three earlier studies (E. M. Drobyshevskiy, MOON PLANETS, Vol 23, p 339, 1980, Vol 24, p 13, 1981; EARTH, MOON, AND PLANETS, Vol 34, p 213, 1986). The evidence therefore supports the hypothesis that there is an internal chemical source of energy in the nuclei of comets which can be caused by volumetric electrolysis of the parent planets. References 35: 6 Russian, 29 Western.

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535.24:523.6

Methods and Algorithms for Processing Television Images of Nucleus of Halley's Comet. Some Results

18640096a Moscow KOSMICHESKIYE
ISSLEDOVANIYA in Russian Vol 25 No 6, Nov-Dec 87
(manuscript received 28 Aug 87) pp 820-30

[Article by R. Z. Sagdeyev, G. A. Avanesov, Ya. L. Ziman, V. A. Shamis and V. A. Krasikov]

[Abstract] About 50 television images of Halley's Comet obtained from the 'Vega' spacecraft at distances of 500-8000 km have now been processed. The main processing stages were: retrieval of images and noise elimination; defining boundaries of nuclear region; discrimination of jets; discrimination of structural elements on nucleus surface; determination of nucleus configuration and size. In a generalized way the article examines the specialized methods and algorithms developed for solution of these problems and the results of their application. An analysis of brightness profiles constructed using sample cometary images revealed that the bimodal nature of the spatial distribution of brightness on some images is attributable to an irregular configuration of the nucleus. A change in the brightness decrease function with increasing distance from the centers of distribution occurs in the region of the boundary of the visible nuclear surface. A smooth transition of brightness from the nucleus to the jets causes breaks in the contour. With increasing distance from the nucleus the brightness of the jets and coma slowly decreases linearly. The algorithms for discriminating jets are based on use of the spatial and textural characteristics of cometary image brightness distribution. The processing results can be used in evaluating the orientation, configuration and extent of the jets, and near the pericenter, in tracing the dynamics of active zones on the nucleus surface. The repetition of details on the nucleus surface on two successive images, reduced to the same scale and projection, confirms the correctness of the method used for eliminating noise. It is still impossible to conclude whether the discriminated structural elements are details of the solid nucleus surface (this will require comparison with 'Giotto' data). The parameters of the triaxial ellipsoid approximating the nucleus were $a = 8.5$, $b = 4.2$ and $c = 4.0$ km. The volume of the nucleus was about 600 km^3 . The mean period of rotation was 54.2 hours plus or minus 1.0 hour. Figures 10.

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535.24:523.6

Photometric Characteristics of Nucleus and Inner Coma of Halley's Comet

18660096b Moscow KOSMICHESKIYE
ISSLEDOVANIYA in Russian Vol 25 No 6, Nov-Dec 87
(manuscript received 8 Jun 87) pp 831-839

[Article by R. Z. Sagdeyev, G. A. Avanesov, B. S. Zhukov, I. V. Zenkin, Ya. L. Ziman, V. I. Moroz and V. I. Tarnopolskiy]

[Abstract] About 1500 images of Halley's comet were transmitted from the 'Vega' spacecraft, some from dis-

tances of 8000-9000 km, making it possible to observe the cometary nucleus as a spatially resolvable object for the first time. These data made it possible to evaluate the photometric characteristics of the cometary coma and nucleus, and on that basis, draw conclusions concerning their geometrical and physical characteristics. (The first results of the TV experiment have already been published in a series of articles.) The television system and its surface and flight calibrations are discussed. In the coma regions close to the nucleus the emission of matter is predominantly in the direction of the sun. This asymmetry is intensified with approach to the circumnucleus region. The 'Vega-2' images show at least 5 jets directed into the solar hemisphere; some of these jets have a fine structure. A comparison of cometary images revealed considerable temporal brightness variations which correlate with observatory measurements and which are indicative of intermittent activity of the cometary nucleus. More than 60 images of the inner coma obtained during the flyby made it possible to carry out its three-dimensional tomographic reconstruction. However, it is still impossible to identify the same surface elements on different photographs. Special studies, however, indicated that there are no significant spectral differences in the nature of reflection in the visible, red and near-IR spectral intervals. Since a rapid increase in the brightness coefficient with a decrease in phase angle is characteristic for dark rough surfaces, it can be concluded that for the brightest sectors of nucleus images, surface scattering predominates over radiative scattering in the coma. Estimates of nucleus albedo are close to the albedo of Phobos and the recently discovered satellites of Uranus. It is postulated that a considerable part of the nuclear matter consists of frozen gases, mostly H₂O ice. The surface of the cometary ice nucleus is covered by a layer of dark porous matter or the nucleus is surrounded by a mantle consisting of particles with a low single-scattering albedo. It appears that the boundary dust layer has a small optical thickness. Figures 7; references 14: 4 Russian, 10 Western.

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535.24: 523.6

Dust Envelope of Halley's Comet Determined by 'PUMA' Instrument

18660096c Moscow KOSMICHESKIYE
ISSLEDOVANIYA in Russian Vol 25 No 6, Nov-Dec 87
(manuscript received 13 Aug 87 pp 840-848

[Article by R. Z. Sagdeyev, Ye. N. Yevlanov, B. V. Zubkov, N. P. Kutyreva, V. N. Khromov, V. D. Shapiro, O. F. Prilutskiy and M. N. Fomenkova]

[Abstract] The 'Vega' spacecraft carried the 'PUMA' instrument for determining the elemental composition of dust particles of Halley's Comet. In the inner region of the coma the density of dust particles as a function of distance to the cometary nucleus varies considerably

more strongly than R^{-2} . The dust envelope of the comet is inhomogeneous and there are regions of increased density with an extent of several hundred kilometers. The maximal intensity of the streams of dust particles falls at the subsolar point. The intensity distribution is asymmetric relative to the comet-sun line and the "evening" part of the nucleus surface is considerably more active than the "morning" part. This is particularly conspicuous for "large" particles ($m5 \times 10^{-12}$ g). The observed inhomogeneity of the coma is apparently evidence of a highly anisotropic nature of the emission of dust particles from the cometary nucleus. The integral mass distribution of dust particles corresponding to the entire flyby reveals the presence of particles up to about 10^{-17} g, and thus refutes the "cutoff" of the mass spectrum predicted by models (about 10^{-14} g). The dust envelope has a highly blurred, diffuse boundary and fine dust is registered at a distance of about 5×10^5 km. Within the envelope there are narrow regions of increased density of dust streams indicating the presence of powerful local sources at the nucleus surface. Figures 6; references 11: 1 Russian, 10 Western.

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535.24:523.6

Analysis of Composition of Dust Particles of Halley's Comet Using Results of 'Puma' Instrument Measurements in Zero Mode Regime

18660096d Moscow KOSMICHESKIYE
ISSLEDOVANIYA in Russian Vol 25 No 6, Nov-Dec 87
(manuscript received 21 Aug 87) pp 849-855

[Article by R. Z. Sagdeyev, Ye. N. Yevlanov, B. V. Zubkov, L. M. Mukhin, O. F. Prilutskiy, M. N. Fomenkova and V. N. Khromov]

[Abstract] In the 'PUMA' mass spectrometers the elemental composition of cometary dust was determined by an analysis of the ion composition of plasma forming at the time of high-velocity (80 km/s) impact of a dust particle against a target. The ions, accelerated to the target potential, are separated by masses in accordance with the target-detector time of flight. The detector system includes a secondary photomultiplier whose signals were fed to the inputs of a special quasilogarithmic amplifier and were summed and converted into digital form for transmission through the telemetric channel. The time-of-flight spectra were registered in modes 0, 1, 2 and 3, corresponding to different methods for signal readout from the quasilogarithmic amplifier. (Figure 1 is a diagram of the 'PUMA-1'.) Analysis of the collected data indicated that the dust particles contain a considerable quantity of light elements. The most natural explanation of this phenomenon is the presence of organic compounds which may be similar to the compounds detected in carbon chondrites (kerogens, amino acids). The presence of noise in the 'PUMA-1' spectrum makes it difficult to find trace components and gives rise to doubts concerning the presence of complex organic

ions in the ion spectra. The composition of dust particles in the region of elements from Na to Fe can be attributed to the presence of silicates and in some cases troilite. The relations among the occurrences of the main elements approximately correspond to those typical for similar solar system formations. The results obtained in the zero mode are consistent with the data for other modes, which are more difficult to process. The isotopic relations of the principal elements (C, Mg, Si, Cl, Fe) on the average coincide with the relations of occurrences of isotopes in the solar system. Figures 4; references 8: 3 Russian, 5 Western.

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523.24:523.6

Classification of Dust Particles of Halley's Comet Determined Using Data From 'PUMA-2' Dust-Impact Mass Spectrometer

18660096e Moscow KOSMICHESKIYE
ISSLEDOVANIYA in Russian Vol 25 No 6, Nov-Dec 87
(manuscript received 21 Aug 87) pp 856-859

[Article by R. Z. Sagdeyev, L. M. Mukhin, Ye. N. Yevlanov, B. V. Zubkov, O. F. Prilutskiy and M. N. Fomenkova]

[Abstract] The 'PUMA-1' and 'PUMA-2' dust-impact mass spectrometers carried on the 'Vega' spacecraft were intended for analysis of the elemental composition of the dust component of Halley's Comet. In the processing of the experimental material 25 zero-mode spectra and 517 nonzero-mode spectra were analyzed. These spectra make it possible to carry out only a qualitative analysis of the elemental composition of the dust particles because at this processing stage no allowance has been made for the processes transpiring in the plasma cloud forming at the time of high-velocity impact. It is nevertheless possible to classify dust particles on the basis of their elemental composition and to draw preliminary conclusions concerning their chemical and mineralogical composition. All particles were divided into three groups: a group containing only light elements (H, C, N, O), a group containing light elements and metals, a group containing metals and oxygen or only metals. Figures 1-3 show typical spectra for the three groups. There were relatively few cases in group 1. under the considered conditions only dust particles consisting of organic molecules of quite complex structure can survive. The particles in this group may include substances such as kerogen, amino acids and higher alcohols whose degradation temperatures are quite high. The second group of particles is represented by 200 spectra. A mandatory condition for inclusion in this group is the presence of C in different combinations with other light elements and metals. The set of elements in these particles is characteristic for carbon chondrites. Groups 1 and 2 account for 80% of all the analyzed particles. The third group of particles consists of metal oxides. Among the 36 spectra of this group, 28 spectra, together with peaks of metals,

sulfur and oxygen, also contain a hydrogen peak. This circumstance can be attributed either to the presence of hydroxyl groups in the minerals making up the main mass of the particles or to remnants of ice or water in particle pores. The question of pure ice particles was studied. Only three spectra could be regarded as possible candidates for ice and no conclusions could be drawn on the basis of available data. Figures 4; references: 11 Western.

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Registry of Dust Particles in Neighborhood of Halley's Comet Nucleus by 'Foton' Instrument

18660096f Moscow KOSMICHESKIYE
ISSLEDOVANIYA in Russian
Vol 25, No 6, Nov-Dec 87
(manuscript received 30 Jul 87) pp 860-866

[Abstract] The "Foton" instrument carried aboard the 'Vega' spacecraft registered damage to a thin shield on the vehicle resulting from impact of a dust particle, the momentum imparted to the shield and the amplitude and duration of the light flash arising at the time of penetration, thereby yielding data which cannot be provided by laboratory simulation. The instrument was intended for registry of relatively large dust particles with masses greater than 10^{-9} g. The instrument is a chamber covered by a thin metallic shield and oriented in such a way that the shield during flyby near the nucleus was illuminated by the sun and was subjected to exposure to the stream of cometary dust particles. The angle of incidence of particles on the shield was 30° . The shield was fabricated of nickel and was 0.1 mm thick with a working surface of 137 cm^2 . Registry of dust particles and determination of their parameters were based on an optical method for measuring the area of the openings punched in the shield. A photometric system registered the flux of solar radiation passing through the openings in the shield and the amplitude and duration of the light flash. The simultaneous registry of several parameters characterizing the high-velocity collision of a dust particle with the shield made it possible to determine the mass and other characteristics of a particle. The maximal mass of a particle registered by the instrument was 6×10^{-10} g. The article deals only with those particles for which all three characteristics of their interaction with the shield (flash energy, momentum imparted to the shield and size of openings) were determined. The total area of the openings was 0.25% of the total working area of the shield. A series of formulas was derived: for the mass distribution of all particles registered during the flyby; rate of dust production; distribution function for dust particles by radius. Figures 3; references 13: 9 Russian, 4 Western.

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Mass Spectrum and Spatial Distribution of Dust in Head of Halley's Comet Determined Using SP-1 Instrument on 'Vega-1' and 'Vega-2' Spacecraft

18660096g Moscow KOSMICHESKIYE
ISSLEDOVANIYA in Russian Vol 25 No 6, Nov-Dec 87
(manuscript received 8 Jun 87) pp 867-883

[Article by O. L. Vaysberg, V. N. Smirnov, L. S. Gorn and M. V. Iovlev]

[Abstract] A systematic description of the results of an experiment with the SP-1 impact plasma detector on the 'Vega' spacecraft is presented. SP-1 operation is based on charge measurement in the plasma cloud forming with high-velocity impact of a dust particle against a thin target. The impact is accompanied by a microexplosion with evaporation and ionization of the dust particle and target material. The target is made of an aluminum alloy covered by gold foil 0.1 mm thick. A diagram of the instrument transducer is given and a table gives the ranges of registered amplitudes of pulses and the corresponding ranges of masses. Very detailed information is given on the spatial and mass distributions. It was found that the mass spectrum of dust particles increases with a decrease in masses in the range of masses 10^{-14} to 10^{-16} g. The observed evolution of the mass spectrum with distance can be attributed to the influence of radiative effects. The dust coma consists of several shells or paraboloids with different characteristics, which indicates the existence of different types of particles. Particles of low mass are observed outside the main paraboloids with apices 266 500 or 45 000 km. A jet was observed with a mass dispersion related to the period and direction of rotation of the nucleus and was used for evaluating the dispersion curves of velocities of particles in the range of masses 10^{-5} to 10^{-10} g. Evidence was collected indicating evolution of particles during the time of their flight in the coma. Particle densities were determined. Figures 10; references 28: 1 Russian, 27 Western.

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Tomographic Reconstruction of Inner Coma of Halley's Comet Determined Using TV Information From 'Vega' Spacecraft

18660096h Moscow KOSMICHESKIYE
ISSLEDOVANIYA in Russian Vol 25 No 6, Nov-Dec 87
(manuscript received 13 Jan 87) pp 884-894

[Article by A. Yu. Kogan and V. N. Kheyfets]

[Abstract] A three-dimensional tomographic reconstruction of the coma of Halley's Comet was made possible due to the videoinformation obtained during the TV

experiment on the 'Vega' spacecraft, constituting a series of images of the circumnucleus region from different angles of view quite densely filling the interval from $-\pi/2$ to $\pi/2$. In addition, single-scattering conditions prevail in the entire volume of the coma, except possibly the thin layer adjacent to the nuclear surface. The tomographic problem was solved by inversion of the Radon transform with certain significant modifications. A full algorithm for this procedure is outlined. Full details are given on reduction of the problem of coma reconstruction to the classical Radon inversion problem. The results of the reconstruction were reduced to graphic form in the form of a series of images of tomographic sections and in the form of level surfaces connecting adjacent points with equal values of the retrieved distribution function. On the surface lines were plotted showing their intersection by a set of planes orthogonal to the spacecraft-comet radius vector at the time of maximal approach to the comet (approximately perpendicular to the direction to the sun). The reconstruction clearly shows that escape from the nucleus occurs predominantly in the direction of the sun. The tomographic reconstruction also reveals some peculiarities of nucleus geometry. Figures 4; references 10: 7 Russian, 3 Western.

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Measuring Concentration of Neutral Particles Near Halley's Comet Using 'PLAZMAG-1' Multipurpose Instrument on 'Vega-1' and 'Vega-2' Spacecraft

18660096i Moscow KOSMICHESKIYE
ISSLEDOVANIYA in Russian Vol 25 No 6, Nov-Dec 87
pp 895-899

[Article by A. P. Remizov, M. I. Verigin, K. I. Gringauz, I. Apathy, T. Semerei, T. Gombosi and A. K. Rikhter]

[Abstract] The concentration of neutral gas near Halley's Comet was measured on the 'Vega' spacecraft using a special Faraday cylinder oriented along the spacecraft velocity vector relative to the comet, constituting part of the 'PLAZMAG-1' instrument package. The results obtained during approach of the 'Vega-1' to the cometary nucleus have already been published. This article gives further details concerning the measurement method and gives additional data obtained by the 'Vega-2' and with withdrawal of the 'Vega-1' from the cometary nucleus. A diagram of the Faraday cylinder used is given and its special features are described. The results of measurements of neutral particles are compared with similar measurements on other vehicles with different instruments. The results reported here conform well to a very simple dependence obtained by Haser on the assumption of radial escape of neutral molecules with a constant velocity and a limited lifetime. This makes it possible to estimate the rate of gas production by Halley's comet. In a number of regions, however, there were systematic deviations from that simple dependence.

These deviations are possibly associated with the jets emitted by the rotating cometary nucleus, in which neutral gas is ejected together with dust. Solar UV radiation scattered by the comet may exert some influence on instrument readings. Solar radiation pressure could exert an influence on the asymmetry of distribution of neutral particles along the spacecraft trajectory. Estimates of the rate of gas production by the nucleus obtained using 'Vega' data are consistent with 'Giotto' data. The distribution of neutral gas in the neighborhood of the comet was therefore reliably determined. At cometocentric distances 2×10^5 to 3×10^6 km the Faraday cylinder was the sole instrument on any spacecraft capable of direct measurement of the distribution of neutral gas along the trajectory. Figures 5; references: 11 Western.

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Position and Structure of Bow Shock Near Halley's Comet Determined From Measurements on 'Vega-1' and 'Vega-2' Spacecraft

18660096j Moscow KOSMICHESKIYE
ISSLEDOVANIYA in Russian Vol 25 No 6, Nov-Dec 87
(manuscript received 13 Aug 87) pp 900-906

[Article by A. A. Galeyev, B. E. Gribov, T. Gombosi, K. I. Gringauz, S. I. Klimov, P. Oberts, A. P. Remizov, W. Riedler, R. Z. Sagdeyev, S. P. Savin, A. Yu. Sokolov, V. D. Shapiro, V. I. Shevchenko, K. Szego, M. I. Verigin and Ye. G. Yeroshenko]

[Abstract] The position of the circumcometary bow shock was determined most precisely with approach of the 'Vega-1' to the nucleus of Halley's comet. The APV-N instrument registered a rapid increase in the intensity of plasma waves less than lower hybrid resonance. During this same period there was a dropoff in velocity and heating of solar wind protons and an increase in magnetic field strength. The position of the bow shock front registered by the 'Vega-1' is consistent with theoretical computations. Measurements of the magnetic field before the front made it possible to estimate the angle between the magnetic field and the normal to the front and to conclude that the 'Vega-1' intersected a quasiperpendicular bow shock. Due to the presence of magnetohydrodynamic turbulence the circumcometary bow shock differs greatly from well-studied circumplanetary bow shocks, making it quite difficult to identify its intersection from jumps in magnetic field strength and the velocity of plasma flow. A study of the bow shock is of great importance for study of non-collision waves in plasma. There are two types of circumcometary bow shocks: quasiparallel and quasiperpendicular. A resistive density jump is formed within a quasiperpendicular bow shock and the magnetic field jump registered by the 'Vega-1' evidently is associated

with that effect. On the other hand, the 'Vega-2' intersected a quasiparallel bow shock, having a completely different nature. Figures 6; references 15: 6 Russian, 9 Western.

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Characteristics of Plasma Transition Region of Halley's Comet Determined Using Data From 'Vega-1' and 'Vega-2' Spacecraft

18660096k Moscow KOSMICHESKIYE
ISSLEDOVANIYA in Russian Vol 25 No 6, Nov-Dec 87
(manuscript received 13 Aug 87) pp 907-913

[Article by M. I. Verigin, K. I. Gringauz, A. Rikhter, T. Gombosi, A. P. Remizov, K. Szego, I. Apathy, T. Semei, T. Tatralyai and L. A. Lezhen]

[Abstract] A circumcometary bow shock was detected by plasma measurements made near Halley's Comet using the 'PLAZMAG-1' instrument package. The bow shock is formed as a result of loading of the solar wind by cometary ions. This article presents experimental data obtained by the 'Vega' spacecraft in the solar wind disturbed by the presence of cometary neutral gas, in the neighborhood of the cometary bow shock and in the cometary transition region and discusses various physical characteristics of plasma in these regions. The data were collected using two electrostatic analyzers. These analyzers measured the energy spectra of ions arriving in the direction from the sun and along the spacecraft velocity vector relative to the comet. The data indicate that ions forming in the solar wind during the ionization of cometary neutral gas initially form a beam in velocity space. Alfvén waves generated by ionocyclotron instability result in rapid isotropization of newly forming ions in a coordinate system moving with the solar wind. Regardless of the angle between the magnetic field and solar wind velocity, after several cyclotron periods the newly forming ions, arriving in the direction from the sun, should have a velocity equal to double the solar wind velocity and an energy greater by a factor of 4 M than the energy of solar wind protons. This helps explain many peculiarities of plasma behavior in the transition region. The characteristic time of variations in the direction of plasma flow in the cometary transition region is 20-30 s. These variations are evidently caused by strong turbulence of the plasma flow caused by the entrainment of newly forming heavy ions into the flow. Very long-period variations of plasma flow in the transition region may also be associated with large-scale magnetohydrodynamic turbulence. Figures 4; references 14: 2 Russian, 12 Western.

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Region of Cometary Ions in Head of Halley's Comet Determined Using Data From 'Vega-2' Spacecraft

18660096l Moscow KOSMICHESKIYE
ISSLEDOVANIYA in Russian Vol 25 No 6, Nov-Dec 87
(manuscript received 13 Aug 87) pp 914-920

[Article by K. I. Gringauz, M. I. Verigin, A. Rikhter, T. Gombosi, K. Szego, M. Tatralyai, A. P. Remizov and I. Apathy]

[Abstract] A quite sharp boundary, the cometopause, separating the outer region, the cometary transition region, controlled by solar wind protons, from the inner region of cometary plasma, where heavy cometary ions predominate, was discovered at a distance 1.6×10^5 km from the nucleus of Halley's Comet from 'Vega-2' flyby measurements. These measurements were made using the 'PLAZMAG-1' instrument package. With vehicle penetration into the region of cometary plasma the flows and concentration of heavy ions increased and their temperature fell. Detailed information was obtained on the dependence of the concentration of heavy ions in the region of heavy ions on cometocentric distance. The cometopause is a chemical boundary in circumcometary space and in the region of cometary plasma there is a quasiperiodic modulation of the concentration of cometary ions; neither of these phenomena is fully understood. However, existence of the cometopause is confirmed by 'Giotto' data. (The physical processes transpiring in the neighborhood of this boundary and the reason for its formation were discussed by M. I. Verigin, et al. in PISMA V ASTRON. ZHURN., Vol 13, No 10, 1987.) A special study was made of the reason for the quasiperiodic modulation of the concentration of heavy ions with a period of about 10 s observed in cometary plasma. Several hypotheses have been advanced to explain the observed fluctuations, but they are probably related to the generation of magnetohydrodynamic waves as a result of instability of the anisotropic velocity distribution of newly forming ions. This instability is associated with the cyclotron resonance of ions with Alfvén oscillations. At distances of several tens of thousands of kilometers from the nucleus the content of ions of the water group was 70-80% and for ions of the CO/CO₂ group—15-20%. Figures 4; references 19: 3 Russian, 16 Western.

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Possible Experimental Detection of Acceleration of Cometary Plasma Associated With Change in Direction of Magnetic Field Determined Using Data From 'PLAZMAG-1' Instrument on 'Vega-1' Spacecraft

18660096m Moscow KOSMICHESKIYE
ISSLEDOVANIYA in Russian Vol 25 No 6, Nov-Dec 87
(manuscript received 13 Aug 87) pp 921-926

[Article by M. I. Verigin, I. Axford, K. I. Gringauz and A. Rikhter]

[Abstract] The 'PLAZMAG-1' instrument package carried on the 'Vega' vehicles was used in simultaneous measurements of the solar wind and circumplanetary plasma. It includes two pairs of wide-angle sensors, each pair consisting of a hemispherical ion electrostatic analyzer and an ion Faraday cylinder. One of these pairs was oriented on the sun (SA and SFC), whereas the other was oriented in the direction of the spacecraft velocity vector relative to the comet (CA and CFC). Measurements with these sensors revealed the existence of a circumcometary bow shock at distances of about 10^6 km from the nucleus. It was discovered that there is a slowing of the solar wind as a result of its loading by cometary ions in front of the bow shock. A boundary, the cometopause, not theoretically predicted, was discovered behind the bow shock in the cometary transition region at a distance of about 1.6×10^5 km from the nucleus. In the stream of ions flowing around the comet a region of cometary plasma was detected in which heavy cometary ions predominate and the composition of ions in this region was determined. In the region of cometary plasma between intersections of the cometopause at entry into this region and with emergence from it the SA analyzer registered virtually no ions arriving from the solar direction. However, on the 'Vega-1' this sensor in the region of closest approach to the nucleus registered a brief burst of ions in the energy range 100-1000 eV. The results of measurements of the plasma ion component during the time of this burst were examined in detail and a possible qualitative explanation of its origin is given on the basis of their comparison with simultaneous magnetic field measurements. It is concluded that the relatively brief and asymmetric burst was an essentially nonstationary and localized event and was caused by motion of cometary ions of the water group accelerated to a velocity of several tens of kilometers per second. This acceleration could be caused by the rejoining of magnetic fields of opposite polarity. Figures 4; references 11: 3 Russian, 8 Western.

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Electron Component of Plasma in Neighborhood of Halley's Comet Determined From Measurements by Electron Electrostatic Analyzer of 'PLAZMAG-1' Complex on 'Vega-2' Spacecraft

18660096n Moscow KOSMICHESKIYE
ISSLEDOVANIYA in Russian Vol 25 No 6, Nov-Dec 87
(manuscript received 13 Aug 87) pp 927-931

[Article by K. I. Gringauz, A. P. Remizov, M. I. Verigin, A. Rikhter, M. Tatrallyai, K. Szego, I. N. Klimentko, I. Apathy, T. Gombosi and T. Semerej]

[Abstract] An electrostatic analyzer of electrons, part of the 'PLAZMAG-1' complex, was used in measuring the electron component on the 'Vega-2.' The analyzer, oriented perpendicular to the plane of the ecliptic, made it

possible to measure electron streams in 30 energy intervals spaced logarithmically in the energy range 3-10 000 eV each second. The article gives the results of electron measurements on this vehicle in circumcometary space and a comparison with the results of similar 'Giotto' measurements. This is illustrated in the specific example, when the 'Vega-2' had intersected the circumcometary bow shock and was in the cometary transition region. In this region the main feature of the energy spectra of electrons is the presence of a clearly expressed maximum of electron streams with an energy E_m of several tens of electron-volts. This maximum was generated by thermal electrons of the cometary transition region; its energy decreases systematically with penetration of the vehicle into the cometary transition region and approach to the cometopause. This decrease in E_m with greater penetration into this region reflects the process of cooling of the electron component of plasma. The electron temperatures in this region decreased by a factor of about 2. This cooling, observed by the 'Giotto' as well, is evidently attributable to energy losses by electrons in the process of their inelastic collisions with cometary neutral gas. There is complete validation for this hypothesis. However, the 'Giotto' did not observe one phenomenon observed by the 'Vega-2': the presence of streams of high-energy electrons at cometocentric distances about $1.5-2 \times 10^4$ km. This gives basis for postulating that the presence of such electrons in circumcometary space is sporadic and is a result of processes of the "substorm" type transpiring there. Figures 3; references 14: 2 Russian, 12 Western.

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523.72

Measurement of Energetic Cometary Ions in Solar Wind Before Bow Shock of Halley's Comet

18660096o Moscow KOSMICHESKIYE
ISSLEDOVANIYA in Russian Vol 25 No 6, Nov-Dec 87
(manuscript received 13 Aug 87) pp 932-942

[Article by K. Kecskemety, T. Kravens, V. V. Afonin, A. Varga, K. N. Ventsel, M. I. Verigin, Lu Han, T. Gombosi, K. I. Gringauz, Ye. G. Yeroshenko, E. Koppler, I. N. Klimentko, R. Marsden, A. Nagy, A. P. Remizov, W. Riedler, K. Szego, M. Tatrallyai, K. Svingenshu, A. Shomodi and G. Erdesh]

[Abstract] The detailed results of measurements of streams of high-energy cometary ions using the 'Tyunde-M' instrument on the 'Vega-1' spacecraft prior to reaching the circumcometary bow shock are presented. The 'Tyunde-M' high-energy particle telescope was oriented perpendicular to the sun-comet axis in the ecliptic plane and registered particles from a direction approximately opposite the direction of spacecraft motion. The telescope field of view was a cone with an aperture angle of plus or minus 25° . In four channels the instrument measured spectra of ion streams in the energy ranges 40-490 keV and 490-630 keV with a 20-keV interval. It

was demonstrated that for these ions to be registered they had to be scattered by pitch angles and accelerated. The possible acceleration mechanisms are discussed. The formulation of the experiment is outlined, the cometocentric profiles of the measured ion streams are analyzed and their relationship to magnetic field variations are discussed. The ion distribution functions are determined in a coordinate system moving with the solar wind. The observations revealed the presence of cometary ions at distances about 10^7 km, far from the circumcometary bow shock. The total increase in ion streams with approach of the 'Vega-1' to the nucleus approximately corresponded to the anticipated increase with loading of the solar wind by cometary ions, but was accompanied by periodic sharp increases in stream intensity. In addition, high-energy cometary ions were detected many millions of kilometers from the nucleus. The observed quasiperiodicity of ion streams at distances 3 to 10×10^6 km from the nucleus is evidently determined by the periodicity of spatial distribution of neutral atoms associated with rotation of the nucleus with a period of about 54 hours. In this case the neutral particles will be distributed in expanding shells with a spatial period equal to the product of the velocity of their expansion and the period of rotation of the nucleus. Increases in the streams of energetic particles may also be observed in the neighborhood of the point of intersection of these shells by the spacecraft. Figures 7; references 29: 4 Russian, 25 Western.

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Research on Plasma Waves on 'Vega' Automatic Interplanetary Stations

18660096p Moscow KOSMICHESKIYE
ISSLEDOVANIYA in Russian Vol 25 No 6, Nov-Dec 87
(manuscript received 13 Aug 87) pp 943-951

[Article by S. I. Klimov, Z. Kravchik, V. Ye. Korepanov, S. P. Savin, V. M. Balebanov, G. B. Simonenko, K. Novak, Ya. N. Aleksevich and A. Yu. Sokolov]

[Abstract] The APV-N instrument was used in the study of low-frequency plasma waves in the neighborhood of Halley's Comet. The program involved study of collective processes in plasma responsible for the formation of fine structures in the region of interaction between the solar wind and the cometary atmosphere and dissipation of solar wind energy in this region; determination of anomalous ionization of the cometary atmosphere in the presence of a magnetized solar wind and identification of ionization mechanisms; and diagnosis of solar wind plasma in the cometary ionosphere by measurement of characteristic boundaries in the cometary plasma mantle. The APV-N analyzer of low-frequency plasma waves was developed for sampling and processing data on fluctuations of ion streams and electric field strength. A block diagram of the instrument is given, accompanied by a detailed listing of technical specifications. 'Vega'

measurements were made beginning at great distances, 2 days prior to a direct encounter with the comet, up to the pericenter and emergence from the inner coma. The presence of boundaries in circumplanetary plasma was detected. In the inner coma the most interesting were sectors of anomalous increase in ionization. An outer boundary at a distance 6 to 8×10^5 km is within the bow shock and is characterized by both wave activity in the range 80 to 10^3 Hz and a far less clearly expressed burst near the lower hybrid frequency (15 Hz) and above. Another boundary at about 4×10^5 km is associated with the outer boundary of the cometary mantle and onset of an increase in the magnetic field modulus. It is characterized by oscillations 10^2 to 10^3 Hz. At the cometopause at a distance 1.5 to 2×10^5 oscillations of about 300 Hz dominate at its outer boundary (at the inner boundary, 800 Hz). Short bursts at low frequencies are also observed for the electric field. Figures 4; references 30: 11 Russian, 19 Western.

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Numerical Modeling of Circumcometary Quasiparallel Shock Waves

18660096q Moscow KOSMICHESKIYE
ISSLEDOVANIYA in Russian Vol 25, No 6,
Nov-Dec 87 pp 952-957

[Article by A. S. Lipatov and I. N. Syrovatskiy]

[Abstract] A bow shock is formed as a result of interaction between the solar wind and a cometary atmosphere. This bow shock may have a quasiparallel or quasiperpendicular structure. Numerical modeling of a quasiparallel bow shock was carried out. The mathematical formulation of the problem and numerical application of a pertinent algorithm are discussed. In this examination of the dynamics of a quasiparallel bow shock a study was made of the joint flow of electrons, protons and heavy cometary ions along the z axis. The electrons are described in a hydrodynamic approximation and protons and ions by the equation of motion of macroparticles. Allowance is made for the magnetic and electrical fields and stream velocity. The modeling was carried out with a spatial grid containing 1000 points of intersection, $60\,000$ macroparticles and $60\,000$ macroions. The equation of motion of particles and magnetic field evolution were integrated using implicit schemes which were used in computing interaction between the solar wind and cometary plasma. The picture of magnetic field disturbance was in agreement with data from direct investigation of circumcometary bow shocks. The modeling revealed that the diffuse structure of the circumcometary quasiparallel bow shock is attributable to development of oscillations of the Alfvén type and the ejection of cometary ions in the undisturbed solar wind. A resonance Alfvén mode develops in the foreshock jointly with hose instability, whereas in the transition region the disturbances are also associated with the development of

cyclotron instability because the concentration of cometary ions, playing the role of a beam, increases sharply. There is disruption of isotropization of the distribution function for the velocities of cometary ions with a considerable acceleration of ions along the magnetic field. The characteristic thickness of the bow shock corresponds to quasilinear estimates and the results of experiments near comets; the results of the numerical modeling satisfactorily describe the principal processes observed at the front of the circumcometary quasiparallel shock wave. Figures 2; references 20: 16 Russian, 4 Western.

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Plasma-Wave Measurements in Neighborhood of Halley's Comet

18660141a Moscow KOSMICHESKIYE
ISSLEDOVANIYA in Russian Vol 26 No 1, Jan-Feb 88
(manuscript received 25 Aug 87) pp 3-8

[Article by R. Grar, M. M. Mogilevskiy, Yu. M. Mikhaylov, O. A. Molchanov, A. Pedersen, J. G. Trotignon, C. Beghin and V. Formisano]

[Abstract] The scientific instrumentation carried aboard the "Vega-1" and "Vega-2" included the APV-V instrument for measuring the electrical field in the frequency range 0-300 kHz and the electron component of background plasma. The electric field was measured using a dipole antenna, 11 m in length, whereas the parameters of the electron component of plasma were measured with two cylindrical Langmuir probes. The intensities of the electrical fields measured using the APV-V spectrum analyzers during approach to the comet were analyzed in detail. The data from the two spacecraft were essentially similar. An increase in wave activity increased with approach to the cometary nucleus. A rapid increase in signal level from the low to high frequencies began 40-50 minutes before pericenter and an intensity maximum was observed at pericenter. Individual intensity bursts were observed by "Vega-2" at a distance of several hundreds of thousands of kilometers from the cometary nucleus which were absent on "Vega-1" records; this was evidently attributable to different conditions in the solar wind. The analysis revealed that in the neighborhood of the comet the wave processes correlate with both magnetic field changes and with change in dust particle concentration. One of the possible explanations of this phenomenon is the charging of dust particles under the influence of solar ultraviolet radiation. The Larmor radius of electrons and ions is considerably less than the Larmor radius of dust particles and therefore electrical currents and instabilities develop at the boundary of the dust plasma which result in the generation of low-frequency waves. Figures 3; references 13: 5 Russian, 8 Western.

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Distribution of Concentration of Heavy Ions in Head of Halley's Comet

18660141b Moscow KOSMICHESKIYE
ISSLEDOVANIYA in Russian Vol 26, No 1, Jan-Feb 88
(manuscript received 8 Jun 87) pp 9-20

[Article by O. L. Vaysberg, G. N. Zastenker, V. N. Smirnov, B. I. Khazanov, D. S. Zakharov, A. V. Leybov, A. O. Fedorov, S. I. Klimov, S. P. Savin, Z. Krawczyk and Z. Zbyszynski]

[Abstract] The BD-3 detector of the APV-N wave instrument on the "Vega-1" and "Vega-2" was used for evaluating the parameters of plasma of Halley's Comet. Data were obtained on the position and thickness of the shock wave front, the distribution of the concentration of heavy ions in the cometary mantle and on plasma convection in the mantle. Details on configuration of the BD-3 sensor and its characteristics are given. Measurements of the ion flux were made on 6 March 1986 along the entire "Vega-1" flight trajectory near the comet, other than a sector near pericenter. "Vega-2" data were registered on 9 March 1986 along a more limited trajectory. The shock wave, mantle of heavy ions, convection of heavy ions and small-scale inhomogeneities are discussed in detail. It was found that the cometary mantle, consisting predominantly of heavy ions, has on its flank a relatively sharp boundary at which the concentration of these ions increases by a factor of approximately 2. On 6 March 1986 this boundary was at a distance of about 150 000 km. This position of the boundary agrees approximately with the model of formation of a mantle of a gas-releasing obstacle in the solar wind. The concentration of mantle ions varies with distance approximately as R^{-2} . An increase in the ion concentration by a factor of 3 was observed on the "Vega-1" in a large region between 66 000 and 25 000 km. A local density maximum was registered at a distance of about 12 000 km on both segments of the "Vega-1" flight trajectory (during approach and separation). The convective velocity of plasma in the outer mantle was approximately 20 km/s. Strong density fluctuations with a scale of several hundreds of kilometers are evidently typical for the cometary mantle. Figures 7; references 45: 3 Russian, 42 Western.

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Flare Clouds as Compact Force-Free Toroidal Configurations (Based on Magnetic Measurements on the 'Vega-1, -2' Spacecraft)

18660141i Moscow KOSMICHESKIYE
ISSLEDOVANIYA in Russian Vol 26 No 1, Jan-Feb 88
(manuscript received 20 Jul 87) pp 57-62

[Article by K. G. Ivanov, A. F. Kharshiladze, Ye. G. Yeroshenko and V. A. Styazhkin]

[Abstract] Experimental profiles of the magnetic field obtained during passage of "Vega-1" and "Vega-2" through an interplanetary cloud on 16 February 1986 are

compared with the approximate theoretical profiles constructed applying a number of assumptions concerning the structure of such clouds (only three attempts have been made to construct such theoretical profiles). Examination of this problem from a new point of view was possible due to observations from two spacecraft. The geometry of the experiment is described in detail. The greatest consistency between theory and the experimental data was obtained with representation of the cloud as a flattened compact force-free toroid whose equatorial plane is approximately parallel to the plane of a great circle passing through the flare of 14 February 1986 parallel to the magnetic axis closest to a flare in a bipolar group. Figures 2; 5 Russian, 4 Western.

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Ballistics Operations for 'Phobos' Mission
18660118 Moscow SOTSIALISTICHESKAYA
INDUSTRIYA in Russian 7 Jan 88 p 4

[Article by N. Ivanov, Doctor of Technical Sciences]

[Abstract] The author comments on tasks which the Flight Control Center's ballistics service is called upon to accomplish in the course of the "Phobos" project for research on the planet Mars and its satellite Phobos with the aid of an unmanned interplanetary station. These tasks are said to include fuel-saving maneuvers which will make it possible to increase the station's payload by several hundred kilograms.

The author relates that the "Phobos" spacecraft is scheduled for launching in July of this year. Plans call for the station to be placed into a near-Earth orbit before

beginning its interplanetary flight. To conserve fuel, the final-stage propulsion unit of the station's launch rocket will accelerate the spacecraft to a speed of only 3,400 meters per second instead of the usual speed of approximately 3,900 meters per second. Final acceleration of the station will be accomplished with its own engines.

Following a flight of almost 200 days, the station's braking engines will be fired at a minimal distance from Mars, and the spacecraft will go into the first of several transitional orbits around this planet, making one revolution every 3 days, the author relates. The station's maximum and minimum distances from Mars' surface at this time will be 76,000 and 500 kilometers, respectively. About 4 weeks later, the station will be shifted to a circular orbit for observation of Phobos. This orbit will be approximately 200-300 kilometers outside the orbit of Phobos. After another 4 weeks have passed, the spacecraft will be placed into two intermediate orbits before making a close approach to Phobos.

A subsequent maneuver for landing a permanent self-contained research station on the surface of this satellite is described. The approach to Phobos will begin automatically, on commands from onboard systems of the interplanetary station. At the closest point, the station's altitude above the surface of Phobos will be approximately equal to the height of a 15-story building. After the lander module is dropped, the station will be placed once again into the orbit of a Mars satellite and used in further studies of the planet, its moons, the asteroid belt and the sun.

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Historical Survey of Biosatellites

18660185 Moscow ZEMLYA I VSELENNAYA in Russian No 2, Mar-Apr 88 pp 33-38

[Article by V. B. Pishchik, Institute of Medical and Biological Problems, USSR Ministry of Health: "Biosatellites: Yesterday, Today, and Tomorrow"; first paragraph is an introductory lead-in to article in source]

[Text] Space endurance record-holder Yuriy Romanenko's stint aboard the orbital complex Mir lasted 326 days. To a great extent, this achievement was made possible by medical and biological experiments conducted aboard Soviet biosatellites.

Ahead of man. In the late 1940s and early 1950s, when the still vague outlines of man's stride into space were beginning to be traced, and cosmonautics was just entering a practical stage, the question arose of what would be encountered by the individual who dared venture into the unknown reaches of space. Concern for the safety and health of man in space always informed the labors of the pioneers of cosmonautics. On the threshold of man's flight into space, their conjectures and assumptions had to be checked and evaluated in order to ensure maximum safety and the conditions necessary for fruitful work in space.

Many of the flight factors that could affect man in space were reproduced on Earth. The most difficult of all was weightlessness, which is virtually impossible to create on the ground. And then to the rescue came the experimental helpers of the medical people and biologists—dogs. Numerous experiments were conducted with them aboard rockets flying at altitudes of 110-450 km (*Zemlya i Vseennaya*, 1970, No 3, p 15—Ed.). These rockets were the prototypes of the biosatellites. For the first time ever, scientists were able to study the effects of short-term weightlessness (for 10-12 minutes) on a living organism. During these flights, the pulse, respiration, and arterial pressure of the animals were recorded, electrocardiograms were charted, and films were made. Nearly fifty dogs flew aboard rockets, many of them a number of times. In conditions of dynamic weightlessness, no changes were observed that would lead one to believe that this factor, so unusual for living organisms, would cause dramatic disturbances in physiological function or behavior. That was our first "brush" with weightlessness. But the encounter with "real" weightlessness was still ahead.

In the autumn of 1957, the first living being to venture into space—the dog Layka—flew aboard the second artificial earth satellite. She was launched into space on November 3. For seven days, information on the behavior and functional state of a living body in conditions of extended weightlessness came back. Layka endured her entry into orbit well and her encounter with weightlessness. Circulation and respiratory indices during her stint in weightlessness confirmed the suggestion made by

scientists that this unique factor did not in itself cause dangerous changes in the state of the physiological functions of the animal. It established the certainty of manned flight into space.

The 24-hour flight of the dogs Belka and Strelka aboard a spacecraft-satellite in August 1960 was of great significance. For the first time ever, living organisms, after flying in space, returned safely to Earth. The experiment's success brought closer the time when man himself would conquer space.

In November 1960, S. P. Korolev wrote in the newspaper PRAVDA "There exist at this time the conditions and means for a Soviet researcher to fly in space. But we must gather more practical experience with regard to launching spacecraft-satellites and bringing them back to Earth safely and reliably."

The physiological research program was expanded considerably during the flights of three subsequent spacecraft-satellites. The biocurrents of the myocardium, pulse and respiration, cardiac tone, change in carotid artery volume, motor activity, and body temperature were recorded in dogs. In addition, images of the dogs were transmitted back to Earth.

The medical and biological research aboard the rockets and the spacecraft-satellites was, in effect, "reconnaissance" in space. It made it possible to lay out a biological display of space plans and to reach the scientifically based conclusion that space flight was possible and could be done with the necessary degree of safety.

Meanwhile, the first manned flight into space remained, by and large, a step into the unknown. Would man be able to fly in space and endure all the attendant factors? Some scientists and specialists were sure that man would not be able to endure the state of weightlessness. Moreover, they suggested that the psyche of an ordinary man could not withstand the encounter with weightlessness or the fear in the face of the cosmic abyss.

The triumphant flight of Yuriy Gagarin aboard the Vostok spacecraft proved the pessimistic predictions to be wrong and showed that man could fly in space. The one-day flight of German Titov aboard the Vostok-2 confirmed not only that man was capable of enduring space flight, but also that he could live and successfully work in space.

During those first, then still brief manned space flights, the medical people and biologists got the answers to many questions concerning longer flights. But animal experiments were still necessary.

The 22-day experiment aboard the Cosmos-110 satellite in 1966 represented an important step in the purposeful study of the effects of weightlessness on the body (*Zemlya i Vseennaya*, 1966, No 4, p 59—Ed.). In terms of time spent in space, it was a record-making stay for

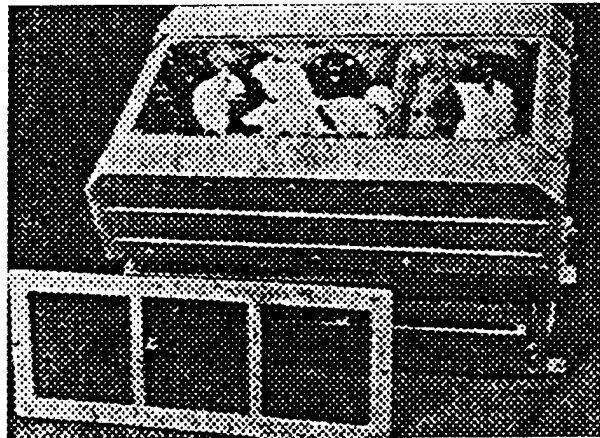
living organisms—the dogs Veterok and Ugolek. At that point, for the first time, rather substantial functional changes were detected in the activity of various systems of the body. Postflight examination revealed disturbances in the water-salt metabolism, especially calcium; muscle atrophy; changes in the biochemical composition of the blood; and disruption of the activity of the cardiovascular system. And although none of these phenomena threatened the lives of the animals, and all were reversible and passed completely a short time after the flight, it became apparent that a profound understanding of the essence of the changes that had occurred in the body would be necessary if manned space flights were to be lengthened and made safe and the adverse effects of weightlessness were to be reliably prevented. An understanding of the mechanisms of the effects of weightlessness on various levels of organization of living systems was necessary.

Animals Aboard Biosatellites. The early 1970s saw the development of an extensive program that studied living subjects aboard specialized biological Earth satellites of the Cosmos series (Zemlya i Vselennaya, 1978, No 4, p 6—Ed.). After 1973, eight biosatellites were launched in the Soviet Union, their flights lasting from 5 to 22 days. The research aboard the craft was complex. Biological subjects of varying levels of evolutionary and individual development were studied.

Thus, the flight of the Cosmos-605 biosatellite (1973) became, as it were, a reference for subsequent purposeful research. The effect of “pure” weightlessness on animals was studied on that flight. Special attention was devoted to structural changes in the body’s systems whose functioning, to a great extent, was associated with the presence of terrestrial gravity.

The combined effects of weightlessness and radiation were studied aboard the Cosmos-690 biosatellite (1974). During the flight, a group of rats was subjected to irradiation from an onboard gamma-ray source. This irradiation simulated the probable radiation effects from a powerful solar flare.

Aboard the Cosmos-936 biosatellite (1977), a group of rats was studied in an onboard centrifuge that produced conditions of artificial gravity equivalent to those of Earth. Postflight studies showed that artificial gravity prevented, to some extent, certain negative effects of weightlessness. Which meant it could be counted among the promising means of maintaining the optimal state of the human body during lengthy space flights. The biosatellite experiments also studied the long-term effects of space-flight factors. A group of male rats that had been in space were kept in ordinary laboratory conditions until they died a natural death. Their lifespans turned out to be no shorter than those of control animals (who had not flown). The offspring produced from breeding males from the flight group two months after they returned to Earth with females who had not flown were no different



Bios unit for maintaining groups of laboratory rats aboard biosatellites of the Cosmos series (Photo by A. Dotsenko)

from the offspring of control animals in terms of number of rats born, birthweight, developmental dynamics, or resistance to various kinds of exposure.

Embryological experiments with a group of pregnant rates aboard the Cosmos-1514 biosatellite (1983) were promising. Part of the period of fetal development took place in weightlessness. After the flight, the offspring of the rats were normal, which pointed to the possibility of the development of a mammalian fetus when the mother’s body is exposed to weightlessness.

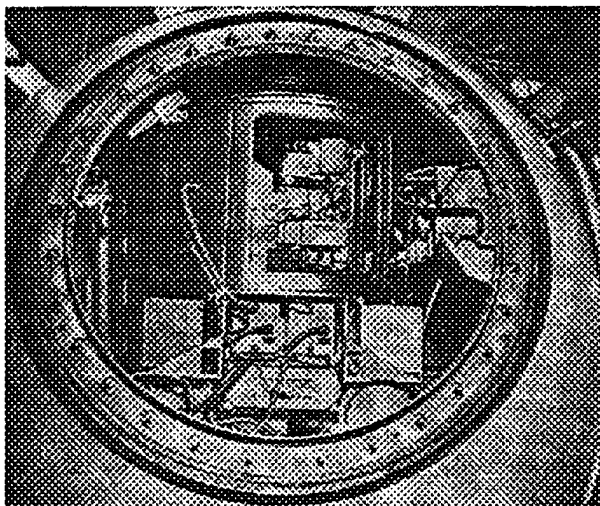
The findings of research performed on monkeys during the flights of the Cosmos-1514 and Cosmos-1667 satellites (1985) and the Cosmos-1887 satellite (1987) were important for understanding the changes that occur in man during the period of acute adaptation to weightlessness. After all, in spite of the wealth of data derived during manned flights, a great many things are still unclear about the mechanism of changes that take place in the first hours and days of space flight, in the so-called acute period of adaptation to weightlessness. Cosmonauts during that period experience a whole series of unpleasant sensations that affect their overall state and efficiency. Animal studies help scientists to better evaluate the various aspects of the phenomena that occur.

Much time is spent selecting and preparing the monkeys for flight. The now famous monkeys Drema and Yerosha, who completed a 13-day flight (the longest for primates) aboard the Cosmos-1887 biosatellite, were chosen from among 50 candidates who had begun training a year before the flight. The prospective space travelers had to be trained to stay in a special capsule and to use nozzles for food and fluids. During the flight, the monkeys performed specific actions according to a special program: they had to press this or that lever when various signals appeared on a panel in front of them. The ability to correctly carry out the program was developed on Earth, and, naturally, not all of the monkeys assimilated the knowledge equally well. Even during the flight,

specialists were evaluating whether the monkeys had retained the skills they had developed and whether they worked as precisely in weightlessness as they had during ground training. It should be noted that in space, all the monkeys (six macaque-rhesus monkeys have successfully flown aboard Soviet biosatellites already) demonstrated an enviable command of operator skills.

The monkeys, as we know, are the closest animals to man in terms of anatomy and physiology. With the use of complex equipment and the most delicate of research methods (which include various sensors that have been implanted into the body), we have managed to evaluate certain quantitative changes in the functioning of the vestibular apparatus, in the distribution of blood in the body, and in the dynamics of indices of the functional state of the muscles and of metabolic shifts. This makes it possible not only to monitor the changes in the body that occur in the initial period of the flight, but also to more fully manage the process of adaptation to weightlessness. For caring for the living subjects aboard the biosatellites and for conducting scientific research, original gear was developed that was unlike any other in biological space research. Such gear includes the capsules for the monkeys and the units for solitary and group containment of rats in conditions of extended weightlessness. On command, the animals are given food and water, waste is removed, and day/night conditions are regulated. Several of the biosatellites are equipped with centrifuges for creating artificial gravity and with gear for irradiating rats. There have also been hothouses for growing plants and aquariums for fish.

The research done on various biological subjects are the "bricks" of which entire notions on the complex interrelationships between living organisms and the space environment are made. It is the opinion of scientists that

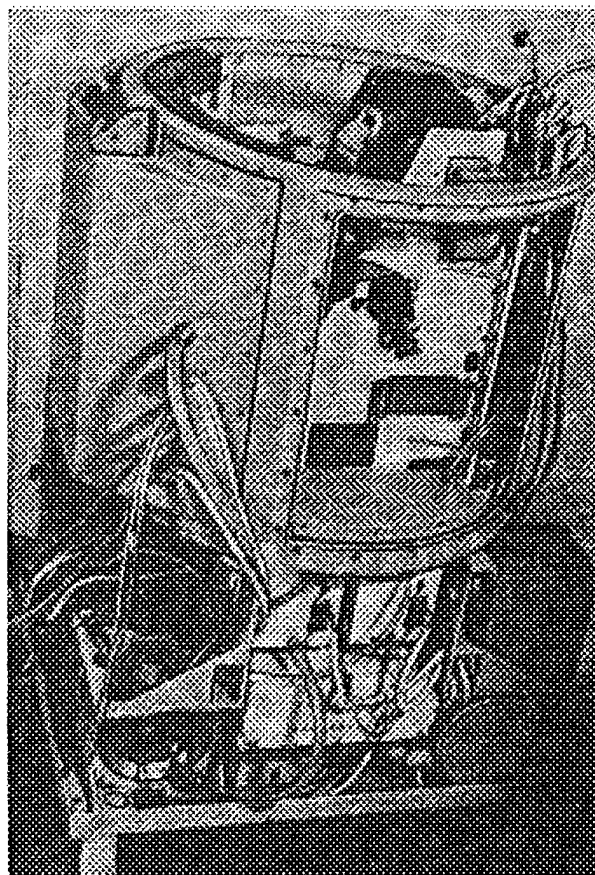


Recovery capsule of a biosatellite of the Cosmos series, with the capsule for maintaining monkeys (Photo by A. Dotsenko)

many of the results obtained aboard biosatellites are fundamental. This pertains especially to the data regarding the fact that weightlessness has no direct damaging effect on intracellular processes, including on the mechanisms for transmitting hereditary information and on cell division. The tissue and organs of animals have showed no pathological or irreversible changes caused by the effects of weightlessness. All this is taken into consideration when the possibility of man enduring lengthy flights is being medically substantiated. The findings of research involving the locomotor systems of animals experimentally confirm the advisability of using dynamic and static physical exercise on manned flights. Moreover, they have made it possible to substantiate several recommendations involving the choice of diagnostic methods for evaluating the state of the human locomotor system during space flight and during readaptation.

Thus, the program of scientific research aboard the biosatellites has made a substantial contribution in the solution of many current and future problems of space biology and medicine.

Looking into the Future. The prospects associated with the development of cosmonautics require the creation of



Monkey in the special capsule used during ground-based training (Photo by A. Dotsenko)



Monkeys Drema and Yerasha after completing space flight (Photo by A. Dotsenko)

autonomous artificial ecology systems aboard future spacecraft. Such systems, which would provide cosmonauts with everything they need in flight, must include various plant and animal organisms. Biosatellite research makes it possible to understand how, for example, plants, birds, fish, and other biological subjects endure space flight and how they develop and live in weightlessness. This enables specialists to choose which organisms to use in the chain that makes up the autonomous ecology system. Methods of monitoring radiation conditions in space and aboard the spacecraft must also be perfected, and possible radiation-shield systems are being developed.

Biosatellite research is making a huge contribution to the understanding of many fundamental problems of natural science, especially the question of the biological role of gravity. The entire evolution of living matter on Earth, at least since the appearance of the cell, has been under conditions of constant gravity. Space flights have opened up the unique possibility of studying the behavior and functions of terrestrial organisms under extraordinary conditions of existence. Scientists have produced a unique instrument for studying the role of gravity in fundamental biological processes. A complete understanding of the effect of gravity on living organisms can be made up only of a comprehensive evaluation of the

effects studied on various systems and on living subjects of various levels of organization.

The development of modern space technology is opening new possibilities in medical and biological research conducted in space. The Soviet space station Mir, now in orbit, is enabling a qualitative step forward. One of its modules may be used as a specialized laboratory for conducting medical and biological research. It will be possible to conduct medical and physiological examinations of cosmonauts in it. In addition, special compartments for keeping animals and other biological subjects are planned for the laboratory. Highly skilled specialists—physicians and biologists—will carry out the studies. After an experiment is finished, part of the biomaterial and certain biological subjects will return to Earth for comprehensive study.

The time when man will make even longer space treks and will set out for other planets is not far away. Our knowledge and experience, including that gained on biosatellites, must prevent adverse changes in the human body and help man to overcome the barriers of weightlessness.

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13227

Advances in Controlling Effects of Weightlessness on Cosmonauts

18660119 Moscow *MEDITSINSKAYA GAZETA* in Russian 27 Jan 88 p 4

[Article by Yu. Faybishenko]

[Abstract] The article is a report of a press conference which took place recently in the USSR Ministry of Foreign Affairs. Attention is focused on results of medical-biological research which was conducted during the mission of cosmonauts Yu. Romanenko, A. Laveykin and A. Aleksandrov on board the orbiting station "Mir." Nearly 170 medical studies in all reportedly were carried out in the course of this mission. Its program included hematologic and biochemical studies of the blood, research of oxygen conditions in body tissues, and studies of the visual analyzer, dynamics of body mass, and the acidity of gastric juice.

At the press conference, Romanenko compared his post-flight experiences with those of a 96-day mission which he completed about 10 years ago. When he took his first steps on Earth after returning from that mission, he felt a great heaviness in his legs and began to sweat, and his heart began to beat faster, Romanenko recalled. Following the latest mission, Romanenko took his first steps while traveling in a helicopter from the landing place to the Baykonur Cosmodrome. This time, his legs supported him steadily, and there were none of the unpleasant symptoms which he had experienced after the earlier mission. A day after the landing, he performed an exercise in which he ran 100 meters, shifted to a walk,

and then ran another 100 meters. Romanenko attributed the difference in his postflight condition to special physical exercises which he carried out during his most recent mission.

Doctor of Medical Sciences A. Grigoryev, deputy director of the USSR Ministry of Health's Institute of Medical-Biological Problems, commented on work which made it possible to lengthen Romanenko's mission by 90 days as compared with the longest previous mission in near-Earth orbit. O. Atkov, a participant in that mission, gathered a large amount of information on how weightlessness affects human beings, Grigoryev recalled. On Earth, useful information was obtained also from an experiment which lasted a year. In the course of this experiment, situations which occur in orbit were simulated with subjects in an antiorthostatic position. During the latest mission, the cosmonauts carried out measures which have been developed for controlling loss of bone tissue caused by washing-out of calcium in conditions of zero gravity. This loss was less than 5 percent in Romanenko's case, as compared with losses of 8 percent which occurred during earlier and shorter missions, Grigoryev reported.

FTD/SNAP

/9604

Cosmonaut Atkov Continues Work in Space Medicine

18660170 Moscow MEDITSINSKAYA GAZETA in Russian 15 Jan 88 p 3

[Article by Yu. Faybishenko]

[Excerpt] Pilot-cosmonaut O. Yu. Atkov heads the department of new diagnostic and research methods at the Institute of Clinical Cardiology of the USSR Academy of Medical Sciences' All-Union Cardiology Research Center (VKNTs).

He went back to work at VKNTs in December of 1984, after the "Mayaki" (the call signs of his crew) had completed a 237-day space mission. He was assigned to head the Institute of Clinical Cardiology's laboratory on functional methods of research, which was created on the basis of the department in which Atkov had previously worked under the direction of Professor N.M.

Mukharlyamov. Following a recent reorganization, this laboratory was combined with a number of other scientific divisions of the institute and a department was formed.

Atkov defended a doctoral dissertation about two years ago. It successfully combines both directions of his scientific interests—space medicine and clinical cardiology.

It is proposed to begin the final tests, before series production, of a portable cardiograph called "Argument" at the cardiology center in a few days. This instrument makes it possible to record the functioning of the heart, particularly its left section, aorta and valves, to study hemodynamics, to measure the thickness of heart walls and to determine a number of other indicators of the condition of the cardiovascular system.

This instrument has had a complicated and unusual career. First a single model of it was built exclusively for specialists working in the field of space medicine, in 1982, and installed on the orbiting station "Salyut-7".

"For the first time in the world, Soviet scientists obtained a picture of a human heart functioning at a distance of about 350 kilometers from our planet," recalled Oleg Yuryevich. "I worked with the 'Argument' also during my expedition in a near-Earth orbit. It proved to be highly reliable and provided much valuable information for space medicine and physiology. Following the mission, cardiologists proposed that a number of corrections be incorporated in the cardiograph. Designers took them into account in developing a version of this instrument for mass production."

O. Yu. Atkov is now taking an active part in drawing up the medical portion of the program of a joint Soviet-French space mission which is to take place this year.

"How often should physicians make space flights, in your opinion?"

"I am firmly convinced that a physician should be a member of the crew on any prolonged expedition. Problems can arise suddenly; a boil may appear, for example. It must be treated without fail. But cosmonauts do not like to talk about their illnesses, particularly ones which are minor from their point of view. But such 'trifles' can lead subsequently to much trouble. A crew needs a physician in order to prevent it."

FTD/SNAP

/9738

Construction in Weightlessness

18660100 Moscow PROBLEMY OSVOYENIYA KOSMOSA (NOVOYE V ZHIZNI, NAUKE, TEKHNIKE: SERIYA KOSMONAVTIKA, ASTRONOMIYA) (signed to press 29 Dec 87) in Russian No 1, Jan 88 pp 36-44

[Excerpt from monograph by Sergey Dmitriyevich Grishin, doctor of technical sciences, and Sergey Vasilyevich Chekalin, candidate of technical sciences: "Problems in the Exploitation of Space"]

[Excerpt]

Construction in Weightlessness

Large-scale structures (LSS's) and the conditions for their operation. The establishment of space structures such as large antenna systems, orbital platforms, industrial complexes and operational centers and SSPP's [satellite solar power plants] is unthinkable without the introduction of LSS's. Individual types of such LSS's are being tested or have already found an application in space technology. Examples of this are the 10-meter space radiotelescope, the KRT-10, the experiment on the deployment and adjusting of which was conducted in 1979 on the Salyut-6 station, and the SB's [solar batteries] for the power supply for the space devices which have even now on the Mir station an operating area of around 100 m² with deployed panels ranging in size up to 30 m. But before going on to the presentation of the problems of deployment and assembly of LSS's in orbits, we will examine in more detail the characteristics of typical LSS's, the conditions for their operation and the demands made on them.

Prospective large-scale on-board antenna systems will have sizes ranging from a few tens and hundreds of meters to several kilometers. The most rigid demands for accuracy in the deviation of the actual surface from the theoretical one will be made on these types of antennas. Thus, for example, for parabolic antennas of an on-board radiometer with diameters of 300, 30 and 4 meters at an orbital altitude of 800 km, the tolerable linear deformations in the structure should not exceed 4.8, 0.35 and 0.11 mm, respectively. The most widespread space antenna structure at the present time is the mechanical one which ensures the maintenance of a given shape for the mirror through the actual rigidity of the frame elements. However, due to the condition that the tolerable deformations be maintained, the maximum size for automatically deploying centimeter-band [SHF] space antennas cannot exceed 200 m, while for millimetric-band [EHF] antennas, it is even smaller.

Of great interest are the plans for rotating space antennas, in which the opening out and maintenance of the mirror shape is accomplished through the centrifugal forces during the antenna's rotation around a focal axis at a constant angular velocity.

In this case the frame is made in the form of a network of flexible fibers with a radially circular layout and is fastened to a central telescopic rod. The rotating structures are compact in storage. The maximum sizes for such antennas, which operate in the meter [VHF] radio wave band, can amount to 1.5-2.0 km. It is true, however, that in the rigidity and attainable accuracy of the reflecting surface the rotating structures are substantially inferior to the mechanical ones.

There exist also plans for space antennas based on an inflated structure, in which the frame is made in the form of an inflated ring with two surfaces attached to it (a reflecting surface and an auxiliary surface) made from synthetic films. The surface tension is ensured by the establishment of excess pressure within the closed band formed by these surfaces, while the maintenance of the antennas' geometric sizes is ensured by a network of flexible quartz fibers attached to the reflecting surface. With regard to the attainable accuracy of the reflecting surface, the inflated structures do not differ from the rotating ones, but have a somewhat smaller relative mass.

Among the promising types of space antennas are structures in which the maintenance of the shape occurs due to electrostatic (or magnetic) forces. The reflecting surface of such an antenna made from a metallic mesh with a parabolic or spherical shape will be fastened to a rigid ring and placed behind it will be an auxiliary conical surface made from a metallic film layered in individual sections and divided by radial and circular gaps. Under the action of opposite charges, the surfaces are attracted to one another and attain the necessary shape. Electrostatic antennas have the identical geometric sizes as deployable mechanical antennas but with a lesser relative mass and can also be used as solar power concentrators.

Plans for space platforms are being considered for promising multipurpose applications satellites. The installation in them of equipment and instrument units of varying purpose based on the use of common service systems for power supply, orientation stabilization and temperature control will make it possible on the whole to reduce the expenditures for the development and operation of such spacecraft. In all the plans for space platforms, starting from the conditions for ensuring adequately high levels of durability and rigidity for a frame with a relatively small mass, a mechanical structure of the space rod truss type composed of standardized elements is being considered. The basic dimensions of the multipurpose platforms (length and width) can range from several tens to several hundreds of meters.

In principle, the very same structures can be used for the SB's as are used for the space antennas. However, the use of the electrostatic method for maintaining the shape of the structure in SB's is accompanied by a large risk of occurrence of an electrostatic breakdown. Mechanical structures are the most widely used for SB's at the

present time. Usually, automatically deploying panel-type SB's are used. With the appearance of flexible film SB's it became possible to send them into space in compressed form (for example, in rolls) with subsequent deployment using telescopic rods, centrifugal forces or inflated structures. At the present time, by their size in their deployed state, SB's are the largest space structures. The deployment in space of such promising constructions as SSPP's is possible only on the basis of girder-type platforms automatically assembled in orbit.

Space edifices for manned lunar bases have much in common with orbital manned complexes. Living quarters should be divided into sealed compartments and equipped with air-lock chambers so the cosmonauts can leave and enter. Inasmuch as the compartments will have internal pressurization, then, based on the condition of maximum durability and minimum mass, they should have a convex shape. The most acceptable shape for living quarters on the Moon's surface is a dome. The use of the lunar soil for protecting the edifices from radiation and meteorites and the active use of the color of the edifices for controlling the heat exchange with the external environment by means of changing the degree of radiation can be specific features of construction on the Moon.

A special feature of the development of LSS's is the necessity of taking into consideration all the external and internal forces acting on them (during deployment and operation), which are frequently disregarded in light of their trivial nature for small-sized space structures. External stresses, which arise during the assembly and erection operations and the transportation of LSS's in space, are caused by the correcting forces during the orientation control of the LSS's, by the particle pressure of the solar radiation, and, for objects functioning in a low, near-Earth orbit (with an altitude of 200-500 km), also by aerodynamic forces. The external stresses can lead to the emergence of bending moments and vibrations in the structure.

Also substantial for the LSS's are tidal forces which strain the structure along the axis which passes through the center of its mass and the Earth's center. This is explained by the fact that, at a distance from the Earth, the Earth's gravitational force decreases and the centrifugal force increases and, therefore, when these forces are equal at the LSS's center of mass, they will not be balanced at the peripheral sections of the structure (those farther from the Earth and those closer to it). If the orientation of the LSS during operation were not significant, then the action of the tidal forces could be disregarded, but the majority of LSS's (space antennas, orbital platforms, space reflectors and SSPP's) need a strict orientation and, in this instance, the tidal forces create an undesirable rotational moment. As a result, during the maintenance of the LSS's orientation with a specified accuracy, vibrations in the structure also arise.

In order to prevent resonance phenomena, the particular vibration frequency of the planned LSS's should be substantially higher than the vibration frequency caused by external forces. Therefore, it is necessary to regulate the external stresses and also to increase the rigidity of the structure through the selection of materials with the needed characteristics.

Among the most widespread internal stresses acting on the LSS's are the thermal stresses, which arise as a consequence of the effect of solar radiation in the illuminated section of the orbit and its absence in the shadow, and also the thermal emissions of the object's individual subsystems. The unequal heating and the thermal deformations of the LSS's caused by this are serious problems. This problem can be solved by reducing the average equilibrium temperature of the structure through the discharge of excess heat into space (the selection of the coverings) and the use of materials with minimal linear expansion coefficients. Less subject to thermal stresses are the rotating LSS's due to the equalization of the thermal loads.

The vacuum of space and radiation represent increased demands on the LSS's. A shortcoming of inflated LSS's is the possibility of their hermetic seal being ruined when they are punctured by a meteorite, as a result of which they become inoperable. In the future, if there is successful development of foaming and self-hardening materials with the needed characteristics, they will find a wide range of applications in space. For rotating LSS's, a particular problem is the development of engines, decelerators and bearings for prolonged operation under the conditions of outer space.

At the present time, the basic demands being made on the LSS's (light weight, durability, rigidity of the space structure, a low linear expansion coefficient, a high decrement in the inherent vibrations and good fatigue characteristics), are being fully taken care of by the composite materials based on carbon plastic and structures of the space rod truss type.

Technology for Assembling LSS's in Space. The assembly and deployment of LSS's in orbit is a qualitatively new and technically complex stage in the development of space technology. Along with the engineering decisions on the selection of the type of structure and the sizing of the structure, the selection of the necessary materials, the determination of the proper procedure for connecting the elements of the LSS's and for assembling it, it is necessary to develop special equipment for assembly and erection operations in space and to develop special diagnostic methods and on-board equipment for carrying out in orbit non-destructive inspection of the LSS's condition. It is necessary to learn how to make a reliable long-term prediction of the behavior of the LSS's elements during prolonged operation in outer space, taking into account the effect of all the factors of the surrounding space environment.

In principle, the erection of LSS's in space can be done using various schemes involving the deployment in orbit of a structure already prepared and assembled on the ground or its assembly from individual elements manufactured on the ground. In the future, it is possible that an LSS will be assembled from elements prepared directly on an assembly platform in space from semifinished products delivered from the ground. At the present time, a certain amount of experience has already been accumulated in the carrying out of assembly and erection operations in space for these first two versions of LSS deployment.

There is the previously mentioned experiment on board the Salyut-6 station in 1979 on the assembly of the KRT-10 radiotelescope, which, during delivery into orbit, was divided into three individual units: The main mirror with a frame made of aluminum rods and a metallic mesh as the reflecting surface, a focal container with an radiator and three telescopic supports and the mechanism for attaching the antenna to the station. Of great practical interest are the experiments on the assembly and deployment of supplementary large-size photoelectric cell panels for the solar batteries on board the Salyut-7 station with a total area of 18.4 m² and for those on board the Mir station with a total area of 26 m².

The Mayak [Beacon] experiment, performed in open space on board the Salyut-7 station in 1986 by cosmonauts L. Kizim and V. Solovyev, encompassed a broad range of tests on the assembly and deployment in orbit of load-bearing girder structures. Tested in space for the first time was the URS special girder-assembly unit, developed and built by the Ukrainian SSR Academy of Sciences' Electric Welding Institute imeni Ye.O. Paton, inside of which was packed a hinged-beam truss capable of being deployed to a length of up to 15 m and, while so deployed, of supporting a special platform with a payload.

Tested at the same time was the modified URI all-purpose hand tool, also developed by the Institute imeni Ye.O. Paton, for cutting, welding, soldering and deposition of metals in open space (the first tests of the URI were conducted on board the Salyut-7 station in 1984). Using the URI it is possible to do welding or soldering of the hinged joints of the girder, which adds to its rigidity and support capacity. In addition to these experiments, tests were conducted on the Microdeformer device in order to study the physical and mechanical properties of the LSS's structural materials as they are being subjected to prolonged and complex stresses under the conditions of open space.

Research and experiments on large-scale space structures are also being conducted in the United States. For example, an experiment meriting attention is the one conducted in 1985 on board the Space Shuttle (the 23d flight) in which the American astronauts manually assembled and dismantled on a rotating jig a "tower"

from tubular components in the form of a rectangular triangular prism 13.7 m high. Spring catches were used to fasten the components together.

Along with the increase in the volume of erection and assembly operations in space, there will be an increase in the level of their automation and further development of the LSS assembly technique using structural components manufactured in orbit from semi-finished products delivered from the ground. In order to do this it will be necessary to develop special automated machines for manufacturing the individual components of the structure, for example, the cylindrical lattice components (the geodesic beams) or the three-sided rod trusses up to several hundred meters in length, which will be used as the basic structural elements of the LSS. And, in order to increase the productivity of the assembly operations in orbit, the cosmonaut riggers will need the assistance of remote-control robot manipulators.

At the present time, several plans for such truss-building units have been worked out. Thus, for example, there is the American plan for an automatic machine for the continuous manufacture of three-sided trusses from a rolled material such as carbon plastic. During the unit's operation, ribbons, from which the spars are manufactured, are unwound from three spools and, passing through a heating unit, are deposited on rollers where the triangular cross-section pieces are formed. After being cooled and hardened in a cooling chamber, these pieces are moved to the assembly site with the components of the strut lattice.

This lattice is manufactured on the ground from a specially cut flat sheet and also wound on three spools. The lattice material during the operation of the truss-maker goes from the spools through the heater into a press-type device, where the cross-section components are formed which are then, just like the spars, are cooled and joined to the latter using ultrasonic welding. In order to control and monitor the operation of the unit, provision has been made for an automatic feedback system which includes the corresponding sensors, servomechanisms, electronic devices and on-board computer.

An important role with the high level of automation of the assembly operations in space is played by the reliable automatically locking connecting joints which simplify LSS assembly and repair operations in orbit and, at the same time, do not require additional power consumption. For convenience in carrying out assembly operations in space, it has been proposed that the erection of LSS's be performed on special construction platforms equipped with various auxiliary equipment. The assembly of relatively small LSS's will be performed at "one site" with relocation or change of position of the assembled structure.

In the instance of the erection of very large LSS's of the SSPP type, the construction platform itself will be moved along the structure as it is assembled. According

to one of the plans, such a platform, 100 x 50 m in size and 5 m high, will include several remote-control manipulators which will perform the assembly according to an autonomous program using a computer, various erection attachments, a servicing station and also automatic truss-building-type machines. Engineering ideas, advancing the capabilities of contemporary technology, are even now solving the problems of future space-based construction.

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Power Supply in Space

18660101 Moscow PROBLEMY OSVOYENIYA KOSMOSA (NOVOYE V ZHIZNI, NAUKE, TEKHNIKE: SERIYA KOSMONAVTIKA, ASTRONOMIYA) in Russian No 1, Jan 88 pp 27-36

[Excerpt from monograph by Sergey Dmitriyevich Grishin and Sergey Vasilyevich Chekalin, "Problems Associated with Developing Space: Cosmonautics and Astronomy": section title, "Power Supply in Space"]

[Text] With the increased complexity of the problems that must be solved and with the longer active service life of spacecraft, the power needs of the on-board equipment are growing sharply. Whereas the on-board systems of the first satellites required several watts of power, the systems aboard today's satellites require as much as several kilowatts, and those aboard tomorrow's satellites will require tens and even hundreds of kilowatts. Thus, according to designs that are being made abroad, a communications satellite of the future, active in geosynchronous orbit for 10 years, will need 10 kW of power; a

multifunctional space platform, 20 kW; and a manned long-term space station, 60-160 kW. Even more power will be needed by the manufacturing installations of the future that will be in near-Earth orbit.

Where does one get that kind of power capacity in space? The answer lies in the improvement of the power-supply systems of today's spacecraft and in new areas of development of space power engineering.

Improving on-board electrochemical power sources. Electrochemical power sources include storage batteries and fuel cells. Storage batteries were used as the main (primary) power sources in the first Soviet and American satellites, and they were used in a number of manned and unmanned spacecraft. At the present time, storage batteries are widely used in combination with other main power sources, such as solar batteries, as an electrical buffer for meeting peak load requirements (communications sessions, orbit correction, on-board experiments), as well as a backup when the operation of the main power source is interrupted (for solar batteries, for example, when the spacecraft is in the shadow of the Earth, and during segments of orbital insertion and landing).

There are several types of storage batteries used in space technology. They have different specific energy or power capacities (calculated per 1 kg of battery weight), different allowable numbers of charge-discharge cycles, and different lengths of service, and, depending on the operational requirements, each type has its own optimum area of application. Table 1 makes it clear that silver-zinc batteries are best used for short-term space flights (several days to one or two months), whereas nothing can compete with nickel-cadmium batteries on long-term flights.

Table 1: Storage Battery Characteristics

Battery type	Specific capacity (practical), W-hr/kg	Specific power, W/kg	Number of charge-discharge cycles	Service life, years
Silver-zinc	90	200	100-150	0.1-0.2
Silver-cadmium	60	120	1000	1
Nickel-cadmium	25-35	80	5000-8000	3-5
Nickel-hydrogen	60	90	2000	1-2

The specific power and operational characteristics of these batteries are close to the maximums that can be achieved with them. That is why the principle areas of work associated with the batteries of the future involve the development of new types. In particular, theoretical and experimental research is being done in the creation of sodium-sulfur and lithium-sulfur batteries that have specific capacities that are 3-4 times greater than what we have now. In these batteries, the sodium and lithium are in a melted state (working temperatures are 300-400°C), which calls for the solution of complex design, materials science, and technological problems.

Over a short service life (on the order of several months), electrochemical generators (ECG) with fuel cells have a higher specific capacity than do storage batteries. Such generators were used in the manned Apollo and Space Shuttle spacecraft, where a rather large amount of power is required for the on-board power sources, and storage batteries are too heavy to be used as a main source.

Oxygen and hydrogen are chosen for fuel cells because of their high power capacity and electrochemical activity. In addition, the water that is produced from the reaction of hydrogen and oxygen can be used for drinking and the daily needs of the cosmonauts, and oxygen for the

life-support system can be stored efficiently in the cryogenic tanks of the power-supply unit. An ECG consists of a number of fuel cells joined one behind the other and the pneumatic-hydraulic units that serve them. The pneumatic-hydraulic units feed the working media to the cells, regulate their parameters, and perform scavenging, as well as remove heat and water. Comparing the parameters of the fuel cells of the reusable Space Shuttle with those of the Apollo craft shows how ECGs with fuel cells can be improved. With the same mass, the fuel cells of the Space Shuttle produce five times more power than do those of Apollo, and they have a service life that is greater by an order of magnitude, with the potential for repeated use and between-flight maintenance. This was achieved with better cooling and distribution of the reagents in the fuel cells and improved electrodes, as well as by replacing the free electrolyte with a matrix diaphragm saturated with electrolyte.

Prospects for use of solar energy. At the present time, solar batteries, in combination with storage batteries, are the most widely used for space-based power-supply units. The principle of operation of the solar battery—the direct conversion of solar radiation into an electrical current—is attractive for its simplicity and reliability. Today's solar batteries, however, have a number of shortcomings. When silicon photocells are used in solar batteries, the efficiency that is achieved today is 12-15 percent, with a theoretical maximum of 22 percent. Based on the fact that solar panels are not completely filled with photocells, and part of the power is lost to resistance in the current conductors, the maximum efficiency of silicon solar batteries is 9 percent, which matches its specific power of 120 W/m².

Solar batteries are subject to degradation (reduction in power output) when exposed to cosmic radiation. Highly pure silicon, with only the smallest traces of other substances, is used to make the silicon photocells more resistant to radiation; and transparent, protective quartz-glass coatings—which also function as heat-regulating coatings—are used. The technology for making solar batteries is still rather complex and expensive.

Solar batteries are being improved in several ways. The greatest promise is held by the use of flexible, roll-up batteries (Figure 8), which are lighter and more compact than the rigid solar panels. In order to reduce the weight of the photocells, film-like photoelectric converters are being developed and work is being done to reduce the thickness of monocrystalline photocells (to 0.05 mm, from 0.2-0.4) and protective anti-radiation coatings (to

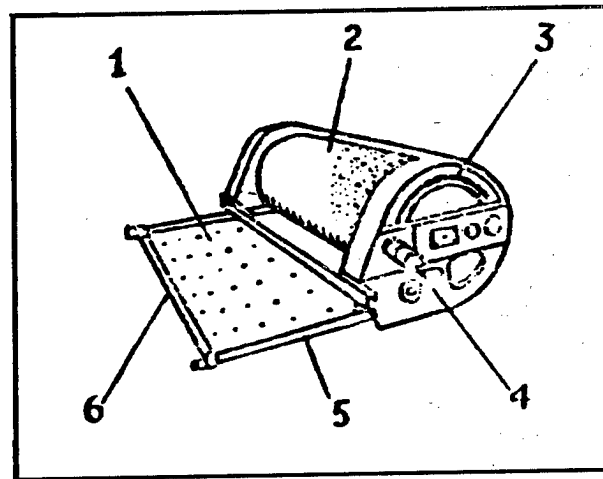


Figure 8. Roll-up Solar Battery: 1—Fiberglass backing; 2—photoelectric converter; 3—drum assembly; 4—electric drive; 5—tubular beam; 6—drawbar

0.05 mm, from 0.15-0.2). Increasing the specific power of solar batteries is possible with solar concentrators, which increase the density of the solar flux.

The most important area associated with the improvement of solar batteries involves increasing the efficiency of photocells and searching for new, more effective semiconductor structures. Research in this area indicates that the possibilities of even such a widely used power element in space as silicon are far from exhausted. Silicon photocells were recently created that are transparent to infrared solar radiation. When the infrared rays pass through without releasing heat, the equilibrium temperature in the cells is lowered, and the efficiency of the cells is thereby increased. Special coatings have been developed that increase the sensitivity of silicon cells to ultraviolet rays, which have the greatest amount of energy, which helps to raise the efficiency of the cells.

In addition to silicon photocells, other promising cells include gallium arsenide cells, which are more efficient and more resistant to cosmic radiation, but are more expensive to produce. Particularly effective, however, is the use of cascade photoelectric converters that combine, for example, silicon photocells and gallium arsenide cells. The fuller use of the solar spectrum makes for a higher total efficiency than with each of the cells used separately. Efficient conversion of solar energy to electrical energy is also possible with complex semiconductor structures, called heterostructures, that are based on compounds like gallium-aluminum-arsenic.

Table 2 compares the efficiencies of such promising photoelectric converters with that of silicon.

Table 2: Efficiencies for Various Promising Photoelectric Converters

Efficiency	Silicon	Gallium Arsenide	Double-Cascade Gallium Arsenide-Silicon Converter	Gallium-Aluminum-Arsenic Heterostructure
Achieved	15	18	28.5	16
Theoretical	22	26	50-60	30

Designs are being developed now for space-based solar-battery power units capable of producing 25-100 kW; the specific mass of solar batteries is expected to be reduced several times over in the near future as a result of the use of new materials and improved technology and construction. From the standpoint of the prospects of the development of space-based solar engineering, designs involving space-based solar power stations [Russian abbreviation: SSE] are attracting special attention. Completion of the designs, as already mentioned, has been postponed until the twenty-first century, but the problems they touch upon are real today and require a closer look.

In spite of the obvious advantages ground-based solar power stations have in terms of safety and ecological compatibility, their wide use is inefficient because of the low density of flux of solar radiation at the Earth's surface and the unstable nature of the operation of such stations as a result of weather conditions, season, and diurnal cycle. Space-based solar power stations are free of such deficiencies. Placed in geosynchronous or sun-synchronous orbit, they will be illuminated by the sun virtually without interruption, and the higher flux density of the solar radiation in space will enable them to collect a substantially greater amount of energy on an average-annual basis than do ground-based stations (6-15 times as much, depending on latitude).

The scales of such space-based stations, by today's standards, are grandiose. Producing 5 GW of power, a station would have an area on the order of 5×10.5 km. The weight of the station, with gallium arsenide converters with flat solar concentrators made of foil, is estimated at 34,100 tons. The station will include powerful amplifiers—units that convert direct current into high-frequency radio energy that is transmitted with a phased antenna with a 1-km array to Earth, where the microwave radiation is reconverted to an electrical current with the desired parameters.

Also of interest are designs for space-based solar stations that transmit energy with lasers. According to calculations, if the electrical energy is converted to laser energy, the laser energy transmitter (at a 10.6μ wavelength) will have an aperture with a 31 m diameter, and the size of the receiving antenna on Earth will not exceed 31×40 m. A laser system could transmit energy not only to Earth, but also to other spacecraft. The relatively high level of atmospheric and cloud absorption of laser emissions can be lowered if the right wavelength is chosen and the Earth-based receiving antenna is located in an area with the largest number of cloudless days in the year.

The design data on the weight and dimensions of a space-based 5GW solar station make it quite apparent that the difficulties associated with assembling such a system, stabilizing its orbit, and controlling its attitude

are immense. Producing long service life in solar batteries is a complex task. According to designs, the photo-cells of a space-based solar station operating for 30 years could have a degradation of no more than 7 percent (by today's estimates, the figure is at nearly 40 percent). From all appearances, designs for space-based solar stations will, in the twenty-first century, undergo substantial alterations based on new achievements of scientific and technical progress and will become economical and technically feasible.

Radioisotope and Nuclear Power Units. There are a number of problems associated with the study and development of space whose solution is impossible or poorly effected with the use of electrochemical or solar power units. We are speaking of flights into deep space, where the level of solar radiation is substantially lower and solar batteries are inefficient. To produce a given amount of electrical power in the vicinity of Jupiter, for example, requires a solar-battery surface area that is roughly 25 times greater than that required in Earth orbit. The use of storage batteries is impossible, because of the duration of the flight of such spacecraft and the limitations on weight.

A new source of power is obviously needed for the energy-capacity tasks of space-based manufacturing both in near-Earth orbit (extremely large areas of solar batteries hamper the operation of orbital complexes) and on the surface of the moon (a power-supply is needed for the lengthy lunar nights).

Radioisotope power sources, or radioisotope thermoelectric generators (RTG), have been used in deep-space research with unmanned spacecraft, where on-board power sources produce no more than several hundred watts. Their principle of operation is based on the use of thermoelectric converters to convert heat produced by the radioactive decay of an isotope into electrical energy. The most important parameters of isotope power sources, depending on their area of use, are half-life and specific heat release (Table 3).

Table 3: Isotope Characteristics

Isotope	Half-life, years	Specific Heat Release, W/hr
Plutonium-238	87.5	0.46
Curium-244	18.4	2.8
Curium-242	0.45	120
Polonium-210	0.38	144

Polonium-210 RTGs were used in Soviet "Lunokhods" for heating during lunar nights. Plutonium-238 RTGs, designed to operate for 12 years, were used aboard the Voyager-1 and Voyager-2 unmanned American interplanetary spacecraft launched in 1977 (flybys of Jupiter, Saturn, Uranus, and Neptune).

Improving the efficiency and specific characteristics of RTGs involves a number of design improvements, including the refinement of the thermoelectric converters.

Nuclear reactor power units are used when powerful, compact on-board sources with long service lives are needed. Satellites with small nuclear power sources have already been developed and placed into near-Earth orbit (the American "SNAP-10A", for example, and the Soviet Cosmos-1402). At the present time, the United States is working to develop a nuclear power unit that produces 100 kW and functions in orbit for seven years. The unit includes a fast nuclear reactor, a radiation shield, a unit that converts thermal energy to electrical energy, and a radiator for removing excess heat. Uranium dioxide is used as fuel. The heat is transferred from the rods to the thermoelectric converter via heat-exchange pipes with liquid sodium.

A drawback of the nuclear reactor is that the crew and the spacecraft's instrumentation must be shielded from the radiation, a factor that complicates and adds weight to the reactor and the power unit. The radiation level is linearly dependent on the power of the source and inversely proportional to the square of the distance from the source. For a 200-kW nuclear reactor located in one of three positions in relation to the spacecraft—on a 10-m boom (with a shield at an angle of 90°), a 100-m boom (45°), or a flexible cable 1000 m long (with all-around shielding)—the weight of the material needed for radiation protection will be 15, 3.6, and 2 tons, respectively.

A complex problem associated with powerful reactors with a long service life is the release of the heat it has used into space. In order to reduce the size and weight of space radiators, researchers are looking for new systems and designs for heat exchangers. In some systems, they are discarding the system of pipes through which the working medium flows. Instead, heated fluid is removed directly into space through a special drop generator, which is a high-pressure chamber with a large number of micrometer-sized openings, in the form of jets that are broken up by vibration into drops (Figure 9). The directed flow of drops lands on the collector. The heat radiates out on the sector between the generator and the collector. The drops combine in the collector into a unified flow of fluid, which is returned by a pump to the closed system. The change from tubular radiators to drop radiators can lead to a reduction of the weight of the surface unit of the radiator by an order of magnitude. The drop radiator is compact and is resistant to damage by micrometeorites.

A radiator in the form of a moving belt has been proposed. Heat that is transferred to the belt with heated rollers or by means of running the belt through a chamber containing the fluid radiates from the surface of the belt. The specific mass of the radiator can be lowered to 1-2.5 kg/m².

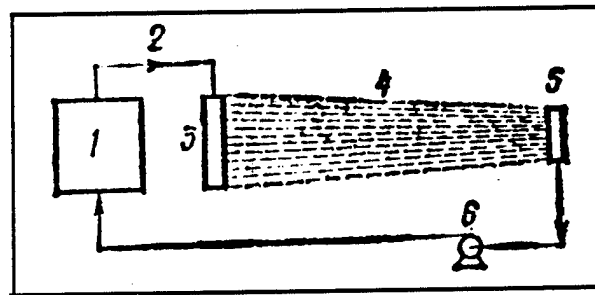


Figure 9. Drop radiator: 1—heat exchanger; 2—flow of hot working fluid to the radiator; 3—drop generator; 4—flow of drops; 5—drop collector; 6—pump

The operation of power reactors in space has advantages over operation here on Earth, since it sharply reduces thermal contamination of the atmosphere and, in the event of an accident, does not threaten the Earth with serious consequences. A high enough orbit needs to be chosen, so that the life of the reactor-equipped spacecraft is longer than the half-life of the radioactive elements in the active zone of the reactor, and a system needs to be in place for disposing of the satellite. Designs are being examined for future space-based nuclear electric power plants that transmit energy to Earth from geosynchronous orbit. It is expected that the fuel can be reprocessed in the orbiting plant itself, and the radioactive waste sent in containers to the sun or to proximate near-sun orbits. A 10-GW nuclear power plant that is based on a nuclear reactor with a gas-phase active zone and is combined with a magnetohydrodynamic generator will weigh a total of about 9000 tons in geosynchronous orbit and can be considered a variation that is competitive with the space-based solar power plant.

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Development of Orbital Welding Technology
18660137 Moscow PRAVDA in Russian 29 Mar 88 p 2

[Article by A. Tarasov: "The MIR Complex, Our Commentary: A Bridge to the Stars Themselves"]]

[Text] Nikitskiy arrived at the train traveling light, not carrying boxes or suitcases. Slender, slightly reddish, frowning. He went from the subway to a railroad car, carelessly swinging a briefcase and a white polyethylene bag.

If the neighbors in the compartment even remotely suspected what was there in that white polyethylene bag they would have formed a line. Samples of materials, not simply from the "Mir" station, but from its lock chamber, virtually from open space.

Three days before these coils with a beautiful film with a copperish hue, these small crucibles with grids, were still in the hands of the cosmonauts Yuriy Romanenko and Aleksandr Laveykin. Now from the railroad station they were carried through Kiev, directly to the Paton Institute. Unfortunately, the director himself was on leave and the delivery of the "Yantar" transpired prosaically, out in the section, surrounded by the squeaking of spherical rods. "We, the undersigned, Nikitskiy and Lapchinskiy, delivered from-received at so many such-and-such samples..." A delivery-acceptance receipt. It is unlikely that these beautiful, shining coils are now intact. Probably they have been cut into small bits for laboratory analyses.

They are wandering from apparatus to apparatus in the beautiful building of the institute's center for physico-chemical research.

For the time being space welds can be counted on the fingers, but everyone knows the name of the first extra-terrestrial welder. This was Valeriy Kubasov, who in 1969, in a flight on the "Soyuz-6" with Georgiy Shonin, switched on the control panel of the "Vulkan" automatic welding apparatus. The welding profession was carried in space, but this was accompanied and is accompanied by agitation.

This required still another meeting, still another burst of creative thought, shining into the future. That is what the meeting of Sergey Pavlovich Korolev and Boris Yevgenyevich Paton, director of the Electric Welding Institute, Ukrainian Academy of Sciences, seemed to me.

The two great designers met. Not "great" due to the positions they held, but due to their ability to create and design a living, specific future by means of clear-cut technical solutions.

However, there are many types of welding: electric arc, plasma, electron beam, contact, explosive. But it was first necessary to select people for space, not technology.

Academician B. Paton was not mistaken in this important matter. Even then, during tests of the "Vulkan" in a flying laboratory of the Cosmonaut Training Center, an excellent group of engineers with "space" and "welding" skills was formed. These are the still unflinching toilers of the Cosmonaut Training Center and the Flight Control Center, where their work on earth precedes work in space.

The final choice in the course of preliminary experiments fell on the electron beam method and happily it was the key which solved a whole host of problems.

"Already during the tests they managed to make a film and in the autumn of 1965 it was shown to Korolev," recalls the laboratory head, V. Lapchinskiy. "He viewed

it together with Gagarin, Komarov, Feoktistov..." Korolev said to him: "You can see what you will have to deal with in a few years..." and he asked that development be speeded up and that the allocated five years be reduced to two....

Then the question: why during a period of 15 years, from 1969, the year of the "Vulkan," through 1984 was welding not repeated in orbit?

The explanation for the most part is related to practical necessity; it dictates everything. Korolev had not been mistaken: it was simply first necessary, taking one measure or another, to do much more than had been supposed. Possibly there are not enough such generators of ideas as Korolev. The "burns" which the experimenters received in the first work also played a role.

...when after the work the ship's evacuated compartment was pressurized and Shonin and Kubasov entered, the table with the "Vulkan" samples was in a pathetic shape. The welding flame had burned through it and had almost cut it in half. This, to be sure, was too much. Either the focusing of the electron beam had changed in the magnetic field, or the support had not moved and all of the heat had been concentrated in one spot.

And although the overall result of the experiment was encouraging and the molten metal was controllable in real space, the business with the table slowed things down. Psychologically it was possible to understand the builders of stations and ships: "What do you want to do, cut through the side and ruin objects? The partisans of metal and fire for a long time felt themselves "personae non grata," and from time to time received apprehensive looks.

What to do? Set the research aside until there was a call for it? Instead the Paton approach was used: not wait, but race ahead. In the space group work continued on developing a welding tool, but now it was a manual instrument. The electron beam was reduced to "pistol" size. The limits of its power was tested, starting from the maximums, of course. Aleksandr Zagrebelnyy since then has brown spots of burns (not psychological, but real) on his fingers. He also worked in a pressure chamber in a spacesuit and gloves and "beat" the samples with electron beams. He "held in his hands" 10 000 volts and felt his hands heated through the gloves and from time to time they became red, like from sunburn.

Everything thus had to be experienced on the ground before being proposed for cosmonauts. At first there were few of the old-time welders who initially believed that it was possible to control a thin and precise beam while in a spacesuit under pressure, through the padding of inflated gloves. Boris Yevgenyevich Paton himself "dived" into the laboratory pressure chamber and tried out the spacesuit and gloves in order to resolve the dispute authoritatively.

At that time cosmonautics solved a rather acute problem: how to restore or apply a coating on space objects and their parts. Space proved to be uncommonly voracious: it ate up paint or the outer layer of material and reduced its strength and longevity. How did space not attack: there were sharp, frequent temperature changes of 200-300°, hard ultraviolet radiation, the solar wind and encounters with micrometeorites... On earth there are no methods for carrying out such tests of service life on a full scale basis. For example, how would it be possible to simulate a 25-year service time when there are 100 000 thermal cycles due to alternation of sun and shadow alone? This is beyond human comprehension.

It is necessary, to be sure, to think about space technology. Nikitskiy had specialized in electrovacuum welding at the institute and his sphere of competence is electron beams, about which he is ready to speak lengthily, like about living people. At the Paton Institute there is an excellent section on electron beam technologies from which originate many unique solutions for science and industry. He went there as if to his parents. But there the leading scientists threw up their hands: "You, my dear fellow, want to take our apparatus, the size of house, and put it into space!"

It is simpler with a vacuum. Whereas on earth it is necessary to spend thousands of rubles to produce a vacuum in small chambers, in space it is free and limitless. Space in essence is an enormous vacuum chamber where things can be done on a grand scale. But it is more complex with respect to energy. At first impression, in order to transform 27 shipboard volts into 5000 V, transform direct current into alternating current and back, and in the process avoid losses, an installation the size of a house would be needed. The best power specialists of the institute, working in collaboration with the Electrodynamics Institute of the Ukrainian Academy of Sciences, came to the rescue. Overcoming all the difficulties, they obtained compact, economical and efficient high-voltage equipment which could be put into space... Using this equipment the Lapchinskiy group could already charge the electron gun for both welding and for spraying.

Here it is, the "grandad" of all sprayers, the "Isparitel-80." A small hexagonal barrel fitting in the airlock chamber from which wastes are usually discharged... The control panel is old-fashioned from the present point of view, but this was a long time ago.

The flight of Vladimir Lyakhov and Valeriy Ryumin took place in 1979. The hearts of the developers stood still awaiting angry comments from above: "What have you palmed off on us again!"

But how wonderful is the solidarity of bold, talented people. The crew took it upon themselves to troubleshoot the instrument. The competence of Ryumin in electronics paid off. "He did not complain to us periodically, but went about his business. But if we said

something intelligent, he always responded. And after all, in-flight repair of space apparatus is about the same as curing tonsils by telephone..." The first samples sprayed with a silver film have arrived on the Earth, there at the institute, from the "Salyut-6." A year later Ryumin and Leonid Popov were quite pleased with themselves. It was apparent that they felt real satisfaction from specific work with a visible result. Even on days off, when there was no one around to interfere, they maintained this psychological support. They pursued the experiment for 30 days in a row. They sprayed 200 samples with copper, gold, silver and their alloys and noted details important for researchers.

The URI, the general-purpose hand tool, without doubt the favorite "child" of the Paton specialists, but also the most difficult, was developed at the same time. "This is something! To hold 5000 volts and 1500 degrees in your hand 'there!'" It was something to fear, something to doubt. But in cosmonautics doubt in general is a mandatory and necessary factor; one has to pass through it. The constructors of stations required their guarantees, the fabricators of spacesuits required theirs, the doctors required theirs, and all were right. A total of about 40 documents confirming agreement from all parties was collected.

"First it was proposed that a system of interlocks be introduced. Let it deviate a little this way or a little that way from the target and the tool would stop working. But this would result in an impossible complication and nothing would get done... And we thought: and what about blocking by man himself: by his reasoning, training, carefulness and sense of responsibility? After all, he isn't an enemy to himself; he won't direct the electron beam at himself or at a comrade."

Faith in the human factor justified itself and helped in solving many problems. Particularly since such a master of space work as Vladimir Dzhaniybekov was involved. If he was involved in any test that meant, first of all, that it was worthwhile, and second, he always assisted, made suggestions and gave advice on how to see the task through to the end. This is the ideal relationship between worker and workers. And how important it is that there are such reliable hands in space!

"Savitskaya taught us a great deal. First, virtually nothing disturbed her: Igor machined dozens of levers for her and one was unsuited, and then another... Then it became clear: she was absolutely right. There it is one-to-one with space, with no nurse or specialist at one's right hand. It was necessary to be ready for any contingency when there was no one to ask. Svetlana was so prepared. She put demands on herself and on others."

The tool was already in orbit when the institute had to give its last approval. That is, give the go ahead. Many were together at the conference, but it seems that there were few responsible figures to say firmly: yes, it is possible! And this after 16 successful tests! Then Boris

Yevgenyevich said: "I will take the responsibility on myself," and gave an "OK" for departure of the working group to the Flight Control Center.

To answer this way means to trust the people who are storming space. Each flight means new agitation, but also new pleasant discoveries in the human factor. There's Leonid Kizim, who had never taken an electrode in his hands, but who from the first training period has worked with the URI as if he had done it all his life. There's Vladimir Solovyev, who proposes designing of apparatus for test checking on board. Indeed, the URI "wintered" on the "Salyut-7" that frightful winter, after which it was "warmed up" by Dzhaniybekov and Savinykh. Was Solovyev right: how did it go? The diagnostic test was made more rapidly than ever, literally en route from Kiev to Moscow, it was checked in the pressure chamber and sent with the "Mayaks" to the ship. And there they are in open space working on samples of joints of a hinged-lever beam.

Here also we see Leonid, who in a roundish spacesuit, looking like a bear cub, climbs on the mast growing on the "Salyut." A special girder assembly apparatus can raise a girder with a payload to a height of 15 meters and can again stow it into a compact "barrel." This also was the work of the space group of Paton Institute specialists. For the time being welding and beams in space are experimental. However, the entire cycle is ready: deployment of construction parts, welding, application of coatings.

And what lies in the future? There are predictions that in the coming centuries mankind will grow to many billions... And artificial satellites, independent in production and supply, but solidly bound into an integrated supercivilization, will be densely settled. Think: there where only two of us now live, Vladimir Titov and Musa Manarov! What will be will be... But "it is necessary to swim into the sea"...

The fully welded Kiev bridge, the child of the patriarch of Soviet electrical welding Yevgeniy Oskarovich Paton, passes from the shores of the Dnepr to the stars. The institute bearing his name is a surprising world of automatic equipment and apparatus. Enormous pieces of equipment for factory, field and underwater. In this range of structures, space equipment occupies a modest place: "Vulkan," "Ispartil," URI, "Mayak"... But it has incorporated the best of which these laboratories, design bureaus and experimental shops are capable. As soon as a new idea is born somewhere in the institute, the Paton motto rings out without fail: "Young people, come together, get acquainted, find what is useful for your purposes."

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629.785:523.42

Analysis of Results of Aerodynamic Research on Landing Modules of 'Vega-1' and 'Vega-2' Stations

18660141c Moscow KOSMICHESKIYE ISSLEDOVANIYA in Russian Vol 26 No 1, Jan-Feb 88 (manuscript received 4 Jun 86) pp 21-27

[Article by S. N. Aleksashkin, V. P. Karyagin, V. M. Kovtunencko, R. S. Kremnev, K. M. Pichkhadze, Yu. A. Ryzhov, R. Ch. Targamadze and A. V. Terterashvili]

[Abstract] The dynamics of motion of the "Vega" landing modules in the Venusian atmosphere are analyzed. Physical modeling methods in wind tunnels were used in solving a number of difficult problems, such as satisfying limitations on the amplitude of change in the spatial angle of attack. The positioning of superstructures and asymmetrically configured instruments on the landing modules resulted in asymmetry of these craft relative to the longitudinal axis, causing the appearance of an inadmissible aerodynamic banking moment. The physical modeling also provided a solution for this problem. The solutions of various other technical problems are described, making it possible to satisfy the many limitations on the admissible range of change in the parameters of landing module motion. The experimental apparatus used in modeling both the angular motion of the model relative to its center of mass and the free movement of the center of mass of the model in the space of the working part of the wind tunnel relative to the transverse axes is described. Various other results of aerodynamic research are given. Figures 7; references: 5 Russian.

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Features of Heat Exchange and Thermal Shielding of Landing Modules of 'Venera' Automatic Interplanetary Stations

18660141d Moscow KOSMICHESKIYE ISSLEDOVANIYA in Russian Vol 26 No 1, Jan-Feb 88 (manuscript received 29 Apr 86) pp 28-32

[Article by I. A. Zelenov, A. F. Klishin, V. M. Kovtunencko and M. D. Nikitin]

[Abstract] The methods used and the results of computations of heat exchange during entry of the landing modules of "Venera" stations into the Venusian atmosphere are summarized. The heat shielding of the landing modules is described in detail. This shielding was selected on the basis of a series of computations taking into account all the limiting conditions for operation of the vehicles. The initial data for the computations were the initial entry parameters, vehicle size, preliminary

data on change in parameters of the entry trajectory with time, dynamics of vehicle descent, model of the Venusian atmosphere, thermophysical and thermoprotective properties of the material used and limiting admissible temperatures of systems and construction parts. The most important of these factors are examined. The article explains the decisive role of radiative heat flows and the dynamics of vehicle descent in heat exchange in the frontal zone. The principles for heat shielding of vehicles of the "Venera" type are outlined and the special ground tests of the heat shielding are described. Figures 4; references: 3 Russian.

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Methods for Maintaining Thermal Regimes of 'Venera' Automatic Interplanetary Stations in Planetary Atmosphere

18660141e Moscow KOSMICHESKIYE
ISSLEDOVANIYA in Russian Vol 26 No 1, Jan-Feb 88
(manuscript received 29 Apr 86) pp 33-36

[Article by I. A. Zelenov, A. F. Klishin, V. M. Kovtunenکو and A. F. Shabarchin]

[Abstract] The choice of the systems for maintaining the thermal regime on the landing modules of "Venera" vehicles was governed by the high atmospheric temperature and pressure at the planetary surface, trajectory parameters of vehicle descent in the atmosphere, duration of functioning of the landing module on the surface, limiting admissible temperatures for systems and apparatus, weight and size of pressurized compartments, systems and instruments, their relative positioning and initial temperatures. The role of these factors is evaluated as applicable to development of the second generation of landing modules. The methods and components used in maintaining the thermal regime are described with particular attention to the thermal insulation. The fundamental principles of the methodology for computing the thermal regime are examined and some specific results of computations are outlined. The systems were subjected to full ground tests prior to their successful use on "Venera" expeditions. Figure 1; references: 3 Russian.

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Thermal Regime of Automatic Interplanetary Stations of 'Venera' Type During Flight Trajectory

18660141f Moscow KOSMICHESKIYE
ISSLEDOVANIYA in Russian Vol 26 No 1, Jan-Feb 88,
(manuscript received 9 Jul 87) pp 37-40

[Article by V. V. Bogdanov and M. M. Yakubovich]

[Abstract] While the "Venera" stations are in outer space en route to Venus they experience a constantly increasing flux of solar radiation whose density varies from

1460 W/m² at the beginning of flight to 2700 W/m² at its end. In addition, maneuvers along the trajectory result in a nonuniformity of external heat flows over the station surface. Some aspects of the thermal regime of the orbital and descent vehicles and other external elements of "Venera" automatic interplanetary stations during the implementation of scientific research on the flight trajectory are outlined. The principles for constructing heat regime maintenance systems are discussed, followed by a description and the principal characteristics of heat regulation systems for the orbital and descent modules of the stations. The results of laboratory research made it possible to select the parameters of active, semipassive, and passive heat regulating systems for equipment and main pressurized compartments and separable compartments and external elements. The role played by each type of system is discussed and their parameters are given. Figures 2; references: 4 Russian.

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Simulation and Interactive Procedures in Search for Landing System Parameters for Automatic Interplanetary Stations of 'Vega-1, -2' Type

18660141g Moscow KOSMICHESKIYE
ISSLEDOVANIYA in Russian Vol 26 No 1, Jan-Feb 88
(manuscript received 29 May 86) pp 41-48

[Article by S. P. Buslayev]

[Abstract] In choosing the parameters of landing modules great expenditures of computer time are required for their simulation, necessitating the finding of effective, economical search procedures. Such landing vehicles include those of the "Vega" type, simulation of whose landing on the Venusian surface requires the computer processing of enormous volumes of information on the parameters of motion and loading of surface elements of the shock-absorbing shell. (A model of landing of the "Vega" modules on the deformable ground of Venus was given by S. P. Buslayev, et al. in KOSMICH. ISSLED., Vol 21, No 4, p 540, 1983.) This article outlines a method for finding the optimal parameters of such landing systems taking into account the random character of the initial landing conditions. A block diagram of such a search is presented. Various aspects of use of computer resources and organization of effective "man-computer" interaction are examined. The peculiarities of the search process resulting from the stochastic formulation of the problem are discussed. It is shown that simulation models of landing make it possible to model the properties of the environment during contact between the lander and ground with a high degree of accuracy. The great duration of computations of the landing process limits the possibilities for dialogue with the computer when choosing lander parameters. However, certain possibilities for "man-computer" interaction are considered. Figures 1; references 11: 9 Russian, 2 Western.

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Stability Analysis of Evaluation of Space Vehicle Characteristics

18660141q Moscow *KOSMICHESKIYE
ISSLEDOVANIYA in Russian Vol 26 No 1, Jan-Feb 88*
(manuscript received 20 May 85) pp 142-151

[Article by V. I. Sukhoruchenkov]

[Abstract] An algorithm has been written for a statistical evaluation of the characteristics of a spacecraft for use in space research which is stable relative the form and parameters of the laws of distribution of the characteristics to be evaluated and the measurement errors. The

algorithm makes it possible to reduce the influence of a priori data on evaluations of spacecraft characteristics. The article gives an iterative algorithm for the joint evaluation of spacecraft characteristics and the covariation matrices of rapidly changing measurement errors. It is shown that the slowly changing components of measurement errors can be included among the parameters to be evaluated without loss in accuracy in evaluating spacecraft characteristics. Expressions are derived for an analysis of stability of the algorithms under experimental conditions. Materials are presented demonstrating the effectiveness of such algorithms. Figure 1; references: 10 Russian.

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Ocean Surface Unevenness Studied by Satellites
18660172 Moscow PRAVDA in Russian 21 Mar 88 p 3

[Article by Ye. Krivenko]

[Excerpt] With the advancement of space research, unevenness of the ocean's surface has begun to attract the attention of naturalists. Reports of 'humps' and 'pits' in the oceans have found their way into the press. Many readers have asked to be told about them in more detail. Just what are they?

We went to the Institute of Oceanology imeni Shirshov and addressed this question to Doctor of Physical-Mathematical Sciences S.S. Ivanov.

"The point is that the force of gravity is not quite identical at different points on our planet," the scientist explained. "If the shape of the Earth is represented as a surface which must be occupied by a still liquid, then this surface is always perpendicular to the direction of the force of gravity at every point. And the direction of this force depends not only on the gravitation of the Earth as a whole but also on the gravitation of individual non-uniformities in the body of our planet.

"To put it rather crudely, an excess of mass hidden inside the planet's body draws together water above it, so to speak. This is the mechanism by which 'bulges' are formed. And a deficiency of mass manifests itself in the form of a 'pit'. Factors deep within the Earth are not necessarily responsible for this. A seamant may often prove to be the cause of a 'hump'. Such a mountain also draws water masses above it together perceptibly. This phenomenon is well-known theoretically. To demonstrate it rationally and even visibly has become possible only with the aid of satellites and space research. Special oceanographic satellites have now been measuring their own distances from the surface of the ocean with high precision for several years. Tracking stations which record elements of satellite orbits determine the true altitudes of the satellites on the basis of such measurements. The designated difference between the two amounts is the index of deviations in the level of the ocean.

"According to theoretical calculations, the largest 'pits' can be up to 100 meters deep. This has been confirmed by measurements that were made. The deepest 'pit' is near the island of Sri Lanka in the Indian Ocean.

"The ocean's surface mirrors its floor relief to a certain extent. And knowledge of what lies deep beneath the water can be used in forecasting tectonic phenomena and surveying possible deposits of mineral resources. It will also become possible to judge dynamics of ocean waters as satellite measurements advance further."

FTD/SNAP

/9738

Optical Plus Radar Satellite Scanning System
18660171 Yerevan KOMMUNIST in Russian 11 Feb 88 p 1

[Text] Kharkov. A system which scientists of Kharkov have developed for radar probing of the Earth's surface has double vision. This new equipment has been successfully tested on board artificial satellites, from which it transmitted clear images to information gathering stations. These images have different depths of focus, so to speak.

V. Shestopalov, director of the Ukrainian Academy of Sciences' Institute of Radiophysics and Electronics, told a TASS correspondent: "The pictures from space simultaneously show processes occurring in high layers of the atmosphere and on the surfaces of land, oceans and seas. One picture is an optical panorama: rows of clouds with black spots appearing in the gaps between them. These spots are mountains, plains and expanses of water. The other image is produced by radar, whose all-seeing 'vision' pierces dense clouds, twilight and even the impenetrable darkness of the polar night. A continuous strip of the Earth's surface up to 500 kilometers long is recorded in full detail in this second picture, with no blank spaces."

Such paired photographs have been obtained for the first time in world practice. The optical and radar pictures are located side by side in two broad strips on photographic paper. The satellite's computer quickly processes and correlates all of the information received from the optical lens and the radar set. The geographic coordinates of the parallel images received on Earth coincide precisely as a result.

With the aid of the space 'eye', river floods can be forecast, underground springs detected in arid zones, the process of ripening of crops in fields monitored, and places of fish concentration in the ocean pointed out to fishermen.

There are now 150 stations for receiving such satellite information in our country.

FTD/SNAP

/9738

Navigation Satellites Fail to Achieve Planned Orbit

18660173 Moscow IZVESTIYA in Russian 19 Feb 88 p 4

[Text] In the USSR Main Administration for Development and Use of Space Technology for the Economy and Scientific Research. The artificial Earth satellites "Cosmos-1917", "Cosmos-1918" and "Cosmos-1919" were launched from the Soviet Union on 17 February 1988. The satellites were intended for perfecting components and apparatus of a space navigation system.

In line with a program, the satellites and a unit for separating them were placed into an intermediate orbit by a "Proton" launch rocket. Further placing of the satellites into their calculated orbit did not take place, owing to irregular functioning of the separating unit's control system.

On 18 February the satellites entered the dense layers of the atmosphere and ceased to exist.

FTD/SNAP

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551.576:551.510.53:629.78

Interpreting Satellite Observations of Orographic Cloud Cover Using Mesoscale Numerical Model

18660129a Moscow ISSLEDOVANIYE ZEMLI IZ

KOSMOSA in Russian No 1, Jan-Feb 88

(manuscript received 12 May 87) pp 3-15

[Article by K. Ya. Kondratyev, G. R. Toroyan and V. I. Khvorostyanov, Limnology Institute, USSR Academy of Sciences, Leningrad; Central Aerological Observatory, Dolgoprudnyy]

[Abstract] An important type of research in observations of the Earth from space is study of the mesostructure of orographic cloud systems forming in mountainous regions during air flow around an orographic obstacle. However, in many cases the interpretation of satellite data is difficult, especially when multilevel cloud cover and a mixed phase state of clouds must be taken into account. This problem has therefore been reexamined by a joint analysis of data on orographic clouds on the basis of satellite observations and numerical modeling. Satellite observations of orographic cloud cover were interpreted on the basis of a mesoscale microphysical model. This is illustrated using a satellite image obtained from "Tiros-1" over the southern part of South America with the formation of cloud cover during the passage of a warm front forming over the Pacific Ocean across the Andean Cordillera. The flow was virtually perpendicular to the range, favoring the formation of internal gravity waves beyond the obstacle. Clouds on the windward side were Ns-As, whereas Sc-Ac and Cu were formed on the lee side. The length of the lee waves was 10-13 km. The process was interpreted by use of a mesoscale two-dimensional nonstationary model with detailed allowance for microphysical processes (including liquid-water content, ice content, concentration of droplets and crystals, radar reflectivity). The discrepancies between model computations and photo interpretation are examined and compared with similar research described in the literature. There was satisfactory agreement between the model and satellite observations. The modeling yielded much information on the physics of the processes governed by orography and made it possible to define the spatial resolution and accuracy of satellite observations required for detecting orographic effects.

The results of such mesoscale modeling can be used in developing and validating methods for the parametrization of orographic effects in models of general circulation of the atmosphere. Figures 5; references 30: 17 Russian, 13 Western.

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551.465: 629.78

Satellite Observations and Numerical Modeling of Interaction Between Synoptic Eddy and Front in Ocean

18660129b Moscow ISSLEDOVANIYE ZEMLI IZ

KOSMOSA in Russian

No 1, Jan-Feb 88 (manuscript received 27 Nov 86)

pp 16-21

[Article by V. B. Lobanov and Ye. V. Yaroshchuk, Pacific Ocean Oceanological Institute, Far Eastern Scientific Center, USSR Academy of Sciences, Vladivostok]

[Abstract] A very simple contour dynamics model of interaction between a synoptic eddy and a front at the boundary of a current is proposed. The results of numerical experiments made it possible to trace frontal disturbances and to demonstrate that there is a good qualitative correspondence with cases of contact between synoptic eddies and the main branch of the Kuroshio observed on satellite images. IR images show narrow bands of arcuate or wavelike configuration with a width of 10-50 km and an extent from several tens to several hundreds of kilometers. The formation of the bands has a quasiperiodic nature and their lifetime is 15-20 days. This phenomenon was studied using IR images of a region to the southeast of Honshu obtained from the NOAA-7 (26 April 1983) and "Tiros-N" (11 May 1980). The numerical experiments revealed that interaction between a synoptic eddy and the shear layer at the boundary of the current can give rise to patterns similar to those on satellite images when there is deformation of the shear layer and entrainment of a zone of current waters into eddy motion (in this process the decisive parameters are eddy intensity and distance to the shear layer). The considerable velocity shear on the current boundary causes a loss in frontal stability. The meanders and eddies which form can favor a decrease in the distance to near-lying synoptic eddies and thereby activate the latter. It is shown that contour dynamics models are a convenient tool for the interpretation of satellite observations. They allow generalization for the case of a two-layer oceanic model, making it possible to take baroclinicity into account in the first approximation. The influence of the beta effect can be included in the form of some external field corresponding to a homogeneous distribution of background potential vorticity. Figures 4; references 10: 7 Russian, 3 Western.

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528.77:550.814+629.78:551.24

**Use of Space Information in Studying
Precambrian Structures**

18660129c Moscow ISSLEDOVANIYE ZEMLI IZ
KOSMOSA in Russian No 1, Jan-Feb 88
(manuscript received 23 Jun 86) pp 30-36

[Article by L. N. Uymanova, All-Union Scientific
Research Institute of Geology of Foreign Countries,
Moscow]

[Abstract] An analysis of space survey data for the central part of East Africa (primarily Ethiopia) yielded important data on ancient stages in development and structure of the Precambrian basement. The modern structural plan was clearly revealed on a low-resolution scanner space photograph obtained from the "Meteor" satellite, distinctly showing the Somali, Ethiopian and Afar megablocks with three important rifts (Red Sea, Aden, Ethiopian). The area is characterized by extensive zones of lineaments of submeridional, northwesterly and sublatitudinal strike, as well as large annular structures up to 250 km in diameter. An interpretation of both the lineaments and annular structures is presented. Particular attention is given to the annular structures which are concentrated in the Somali megablock, especially that centered on Lake Shamo. The joint interpretation of space photographs, geological maps and geophysical data clearly suggests that large annular structures are all situated within the limits of uplifted basement blocks (consistent with the structural map of the basement surface compiled on the basis of seismic prospecting data). Within these structures there are major positive gravity anomalies associated with relief irregularities of the crystalline basement surface. At the base of the large annular structures there may be granite-gneiss ovals which formed in the pre-Late Proterozoic, the period of formation of the continental crust. In the Late Proterozoic, during formation of the rifts, the consolidated sialic crust was broken into large blocks. The next epoch of intensive deformations was Neogene-Quaternary rifting, increasing fragmentation of the Shamo granite-gneiss oval. These and other findings indicate that space photographs are an important source of information for research on ancient tectonic zones and their structural features. Together with geological and geophysical data, interpreted space photographs make it possible to study the history of formation of such zones and to examine their geodynamic features at different stages in their development, which is highly important in the exploration for minerals. Figures 2; references: 2 Russian, 2 Western.

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**Remote Methods for Monitoring and Predicting
Entomological Conditions in Taiga-Covered Areas**

18660129d Moscow ISSLEDOVANIYE ZEMLI IZ
KOSMOSA in Russian No 1, Jan-Feb 88
(manuscript received 25 Oct 85) pp 48-55

[Article by A. S. Isayev and V. Ya. Ryapolov, Forest and
Cellulose Institute imeni V. N. Sukachev, Siberian
Department, USSR Academy of Sciences, Krasnoyarsk]

[Abstract] Important research is being carried out for improving aerospace methods and apparatus and data processing procedures for obtaining information on the pathological state of forests, including research on the population ecology and spatial distribution of centers of various species of insect pests. The latter type of work is being pursued at the Forest and Cellulose Institute on the basis of multiyear materials on the population dynamics of the most important forest insect pests and also using the landscape-ecological approach to analysis of the spatial distribution of the centers of their large-scale reproduction. This type of work is illustrated by research in the central and southern parts of Krasnoyarsk Kray, where such outbreaks occur periodically. Spectrozoal aerospace photographs were used in evaluating forest structure and the dynamics of forest damage. The degree of damage, for example, is evaluated using survey photographs taken in different years. An annual aerial color survey makes it possible to assess the structure and typology of the most damaged sectors. The objective of such work is implementation of control work to prevent and suppress outbursts and prevent expansion of centers of mass insect reproduction. Forecasts of weather conditions favorable for the large-scale reproduction of pests are used in annual research on insect population density. When there is a sharp increase in the insect population a large-scale aerial color survey is made at 1:5000 with resolution on the ground not less than 0.5 m. The detected pathological sectors are mapped from aerial photographs and space-time models of their potential propagation are constructed. Such remote monitoring of the dynamics of forest damage makes it possible to plan and organize measures for forest protection. Figures 2; references: 18 Russian.

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551.4: 528.77+629.77

**Study and Mapping of Forests Using Materials
From Winter Space Scanner Survey**

18660129e Moscow ISSLEDOVANIYE ZEMLI IZ
KOSMOSA in Russian No 1, Jan-Feb 88
(manuscript received 18 Mar 86) pp 56-65

[Article by V. I. Kravtsova and Ye. R. Salakhedinova,
Geography Faculty, Moscow State University imeni M.
V. Lomonosov]

[Abstract] The results of experimental work on the interpretation of forests in the southern taiga subzone in

the European USSR on scanner photographs taken during winter are discussed. Photographs taken by high- and medium-resolution scanners from the "Meteor-30" satellite were used. The basic material used in the study was a photograph taken with the "Fragment" high-resolution experimental multizonal scanning system in February 1983, taking in the northeastern and eastern regions of Kostroma Oblast and a small sector of Vologda Oblast. Images in the orange (0.5-0.6 μ m) and red (0.6-0.7 μ m) zones, enlarged to a scale 1:500 000, were used. Such a photograph clearly shows the boundaries of forests which stand out in the form of areas of dark gray and gray tone against the white background of snow-covered unforested sectors, with forests occupying 60-70 percent of the area. Since it is a very old lumbering region, the original forest is being replaced by secondary species (birch, aspen and a mixture). The Geobotanical Map of the Nonchernozem Zone of the USSR at 1:500 000 is of assistance in the interpretation of such photographs. An important interpretation criterion is the optical density, which differs for coniferous forests, mixed forests with a predominance of conifers, mixed forests with a predominance of hardwoods and hardwoods. It could be determined that the studied area consists of 30 percent conifers, 40 percent of a mix and in 30 percent of the area the primary forest has been totally replaced by secondary species. Although winter photographs do not make it possible to classify forests by species, they correctly reveal the relationship between conifers and hardwoods. Another study was made using a photograph at 1:5 000 000 taken with the MSU-S medium-resolution scanner system in February 1984 in the range 0.7-1.1 μ m. This photograph had relatively little to offer, although it was possible to discriminate forests with a predominance of conifers and with a predominance of hardwoods. The "Fragment" photograph of 1983 was compared with the general topographic map of 1947 at 1:300 000 in order to ascertain forest dynamics over the course of an almost 40-year period. It revealed forest annihilation over a large part of the area. Comparison of space photographs for the winters of 1976 and 1983 made it possible to trace forest dynamics over a 7-year period. Such interpretation data can be used in preparing a whole series of informative maps useful to lumbermen, forest managers and environmentalists, but only a high-resolution scanner survey is useful for this purpose. Figures 6; references: 6 Russian.

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633.1 :629.78

Linear Combinations of Spectral Brightness Coefficients in Analysis of Agricultural Vegetation

18660129f Moscow ISSLEDOVANIYE ZEMLI IZ KOSMOSA in Russian No 1, Jan-Feb 88
(manuscript received 12 Sep 86) pp 95-103

[Article by T. A. Nilson, Astrophysics and Atmospheric Physics Institute, Estonian Academy of Sciences, Tartu]

[Abstract] Various linear combinations of spectral characteristics of radiation reflection have come into wide

use in studying vegetation by remote optical methods. Linear combinations of spectral brightness coefficients (SBC) or spectral brightness (SB) (which are obtained as the eigenvectors of the corresponding correlation (covariance) matrix) have been used by a number of authors. The two most important eigenvectors can be interpreted as some brightness and greenness characteristics. The application of linear SBC of the soil brightness and greenness type is demonstrated in this article on the basis of the results of surface measurements of the SBC of fields of agricultural crops carried out at the Astrophysics and Atmospheric Physics Institute, Estonian Academy of Sciences. The SBC measurements were made with a field four-channel photometer in fields of grain crops and in experimental barley plots by a method described by T. A. Nilson, et al. (ISSLED. ZEMLI IZ KOSMOSA, No 5, pp 72-80, 1983). Formulas are derived for computing the soil brightness and greenness indices in four spectral intervals or only in the red and IR. The significance of the projective cover of plants is examined, as well as the seasonal trajectories of greenness and soil brightness indices for grain crops (separately for the sprouting-earring and earing-total maturity stages). Despite definite advantages in the analysis of seasonal variability of the reflection characteristics of agricultural vegetation on the greenness-soil brightness plane, it is impossible to obtain universal SBR and GR curves for each crop since these curves vary from year to year as a function of weather conditions, presence of weeds, projective cover and other factors. The use of linear combinations of SBC or SB of the greenness and brightness type has definite advantages over SBC or SB themselves. It makes it possible to interpret linear combinations as physical or biological factors and to determine the role of these factors in the spatial or temporal variability of the SBC and to reduce the volume of data. However, linear SBC or SB combinations have shortcomings, such as sensitivity to all the factors determining the SBC. For this reason nonlinear SBC or SB combinations must also be considered. Figures 4; references 10: 5 Russian, 5 Western.

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551.25+681.3:528.77

One Statistical Approach to Automated Discrimination of Linear Elements on Aerospace Photographs

18660145a Moscow DOKLADY AKADEMII NAUK SSSR in Russian Vol 299 No 1, Mar 88
(manuscript received 26 Dec 85) pp 76-79

[Article by L. P. Argunov, V. N. Dementyev, I. A. Igumenova, V. P. Pyatkin, G. I. Salov and V. B. Spektor, Computer Center, Siberian Department, USSR Academy of Sciences, Novosibirsk; Central Multidiscipline Specialized Expedition, "Yakutskgeologiya" Geological Production Association, Yakutsk]

[Abstract] The discrimination of faults on the Earth's surface and the surfaces of other planets from aerospace photographs can be automated, but current procedures

are in certain respects subjective and a number of errors are possible. Specialists at the Computer Center, Siberian Department, USSR Academy of Sciences, in collaboration with the "Yakutskgeologiya" Geological Production Association, have prepared an algorithm and program for automated objective and quite rapid detection of faults. Using this algorithm a conclusion is drawn as to the presence of a fault for each direction on the basis of checking of a statistical hypothesis for the processed image fragment (the algorithm is briefly described). Small-scale scanner, MKF-6 and aerial photographs at different scales were used. Testing of the algorithm revealed results superior to visual techniques, making possible discrimination of a considerably greater number of linear elements, objective discrimination of zones of clustering of linear elements, classification of fragments on the basis of characteristics of the detected linear elements and automated comparison with other geological-geophysical data and maps of mineral deposits. Application of the algorithm is illustrated using a medium-scale aerial photograph of a small area in the eastern part of the Siberian platform in the Yakutsk kimberlite-bearing province. Use of the algorithm and computer made it possible to define three zones with characteristic patterns. It is deduced from known deposits that kimberlite shows are associated with zones of type I, narrow zones having a high density of linear elements with a common strike. This example shows that the algorithm can be useful for mineral prospecting purposes. Figures 3; references: 5 Russian.

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551.583:341.12

Climatological Time Series of Satellite Observations of Earth's Radiation Budget

18650145b Moscow DOKLADY AKADEMII NAUK SSSR in Russian Vol 299 No 1, Mar 88 (manuscript received 30 Dec 87) pp 88-94

[Article by G. I. Marchuk, academician, K. Ya. Kondratyev, academician, and V. V. Kozoderov] Understanding of the processes of interaction between the atmosphere, ocean and land surface is important for confirming the existence of energy active zones in the ocean (EAZO) as anomalies in the field of year-to-year dispersions of the Earth's radiation budget and also for reliable identification of regions of climatic effect of EAZO from satellite data. Valid results of numerical modeling and analysis of satellite data can make an important contribution to detection of predictability of the corresponding atmospheric-oceanic processes. In the mathematical description of this type of relationships it is natural to turn to analysis of the main components of variability of anomalies of fields of the Earth's radiation budget observed from satellites. In discriminating the main modes of oscillations of such anomalies it is customary to use the results of analysis of empirical orthogonal functions (EOF) (eigenvectors of the corresponding covariation matrices). This article gives the results of analysis of the main components of anomalies of the mean monthly fields of outgoing long-wave radiation with an interval 5° in latitude and longitude for the entire Earth. Disturbances of the studied fields with a characteristic horizontal scale of about 2500 km are

described. The data used include two time series based on NOAA satellite data for 42 months of continuous observations and Nimbus-7 observations for 60 months. Two modes were discriminated, the first representing the existence of characteristic anomalies in a number of regions of the Earth, whereas the other corresponds to considerably smaller-scale formations in different parts of the Earth. The eigenvectors and the eigenvalues related to them determine the anticipated variability of the anomaly fields. These two modes seemingly account for only 25 percent of the total variability because within the anomaly fields there are periodic components which must be filtered out in order to give a correct picture. For example, the spectrum of the first mode is characterized by clearly expressed peaks at periods of 21-26 months. The entire Earth is characterized by a still longer-period variability with a period of about 50 months. The spectra of the first three modes are also characterized by 4- to 6-month oscillations. Analysis of the spatial distribution and temporal variation of the pertinent coefficients makes it possible to study the influence of EAZO within individual clusters and to compute the phase velocities of movement of the corresponding formations, thus making it possible to reduce the problem of predictability of EAZO effects within clusters to evaluations of the cross-correlation of anomalies of the long-wave component of the Earth's radiation budget and their standard deviations. Figures 3; references: 5 Russian, 3 Western. Russian.

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528.813

Diagnosis of Dynamics of Stratospheric Ozone in Annual Variation From Satellite Data

18660147a ISSLEDOVANIYE ZEMLI IZ KOSMOSA in Russian No 2, Mar-Apr 88 (manuscript received 30 Dec 86) pp 3-10

[Article by A. N. Gruzdev and I. I. Mokhov, Atmospheric Physics Institute, USSR Academy of Sciences, Moscow]

[Abstract] The dynamics of stratospheric ozone in its annual variation was studied on the basis of zonally averaged mean monthly data on the ozone mixing ratio at levels from 20 to 0.4 mb (25-50 km) from 80°N to 80°S on the basis of satellite measurements made in 1978-1982. The study was made using the amplitude-phase characteristics method proposed earlier by I. I. Mokhov (METEOROLOGIYA I GIDROLOGIYA, No 5, pp 80-89, 1985). This made it possible to determine the dynamics of the ozone mixing ratio in the upper and middle stratosphere in the southern and northern hemispheres, in the polar and equatorial latitudes. Figure 1 shows the isochronal limits of regions of increase and decrease in the ozone mixing ratio for December, March, June and September in latitude and altitude; Fig. 2 shows the dynamics of different phases in the annual variation in latitude and altitude; Fig. 3 shows the times

when the local ozone mixing ratio maximum is attained in its annual variation in the stratosphere as a function of latitude and altitude. The findings represented in the figures are discussed in detail in the text. The results can be used in detecting and confirming the mechanisms determining the dynamics of ozone, for testing photochemical, radiative-photochemical models and models of general circulation of the atmosphere. Figures 3; references 8: 3 Russian, 5 Western.

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Evaluating Optical Thickness of Stratospheric Layer of Aerosol of El Chichon Volcano Over Sahara

18660147b Moscow ISSLEDOVANIYE ZEMLI IZ KOSMOSA in Russian No 2, Mar-Apr 88 (manuscript received 30 Jan 87) pp 11-16

[Article by I. V. Koppelmaa, R. Y. Ryym and K. A. Eerme, Astrophysics and Atmospheric Physics Institute, Estonian Academy of Sciences, Tartu]

[Abstract] A considerable increase in lower stratosphere brightness in the latitude range 0°-40°N was registered during measurements of the Earth's daytime horizon in the summer and autumn of 1982 from the "Salyut-7" orbital station. The greatest brightness increase was registered on 6 July over the Sahara. Six series of measurements were made over this region. This article describes a method for retrieving the main characteristics (altitude, geometrical and optical thickness, source functions) of the geometrically thin stratospheric aerosol layer on the basis of smoothed data from sounding of the daytime horizon. The method was used in retrieving these parameters in the case of El Chichon aerosol over the Sahara. A very simple algorithm is proposed for solving the problem. Retrieved data are given for all six experimental sections. It was found that the optical thickness of the volcanic dust ejected into the stratosphere by El Chichon was comparable to the optical thickness of the entire aerosol atmosphere under ordinary conditions. The influence of background aerosol on horizon brightness was investigated. It is shown that the influence of background aerosol cannot be neglected at altitudes below 12-13 km (below the mean tropopause), but above this level the approximation of an isolated layer is entirely acceptable. Figures 3; references 11: 8 Russian, 3 Western.

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Parameters of Eddy Structures and Mushroom-Shaped Currents in Baltic Sea Determined From Satellite Images

18660147c Moscow ISSLEDOVANIYE ZEMLI IZ KOSMOSA in Russian No 2, Mar-Apr 88 (manuscript received 17 Nov 86) pp 29-35

[Article by I. A. Bychkova and S. V. Viktorov, Leningrad Division, State Oceanographic Institute]

[Abstract] All recently collected data on eddy structures and mushroom-shaped currents detected on satellite

images of the Baltic Sea were generalized for determining the main parameters of these structures, their classification by region and frontogenesis mechanism. In the Baltic there are several types of mesoscale eddies: frontal, advective, topogenic and frictional (each of these types is described in detail); Fig. 1 illustrates these types of eddy structures; Fig. 2 illustrates various types of mushroom-shaped structures. Most of the eddies have a cyclonic rotation. The mushroom-shaped currents contain two eddies simultaneously (cyclonic and anticyclonic), although in the IR range only the cyclonic part can be observed in some cases. A mushroom-shaped structure can be identified by analyzing a number of successive IR images. The lifetime (several days) of these structures is less than the lifetime of eddies. A distinguishing feature of eddy formation in the Baltic is the presence of extensive eddy chains frequently registered from satellites in definite zones. A detailed classification of mushroom-shaped structures is given: those caused by circulation of coastal waters and local wind conditions; those caused by river runoff; those caused by a change in water exchange through straits; those caused by instability of fronts and currents. It is shown that satellite data make it possible to trace the generation, dynamics of development and disappearance of eddy and mushroom-shaped structures. The best time for observing these phenomena from satellites is May-August. In the open part of the sea the most commonly observed eddy structures are of an advective origin. Data can be collected which make it possible to estimate the quantity of energy transported by eddies or mushroom-shaped currents and their contribution to the dynamics of water masses. Figures 2; references 10: 8 Russian, 2 Western.

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551.465:629.78

Statistical Analysis of Surface Distributions of Chlorophyll and Temperature Fields From CZCS and AVHRR Satellite Scanner Images

18660147d Moscow ISSLEDOVANIYE ZEMLI IZ KOSMOSA in Russian No 2, Mar-Apr 88 (manuscript received 27 Oct 86, after revision 25 Feb 87) pp 36-43

ermophysics and Electrophysics Institute, Estonian Academy of Sciences, Tallin]

[Abstract] The statistical characteristics (spatial variability and coherence spectra) of the concentration of phytoplankton pigments (CPP) and ocean surface temperature (OST) determined using data from CZCS and AVHRR scanners are analyzed. Most of the data used were for three sectors in the California Current. A total of 921 sections with lengths up to 561 km on 26 images were processed. Smoothed evaluations of the autospectra, cross-spectra and rms coherence spectra were obtained in the wavelength range 2-100 km. The characteristic form of the rms coherence of CPP and OST is best manifested at the lower confidence limits of the spectra where random fluctuations are suppressed. It was

found that the CPP spatial variability spectra in the studied band are more variable and less steep than the OST spectra. There is a tendency to a decrease in slope of the CPP spectra at the shorter scales. Under typical oceanic conditions the CPP spectra are close to a "white noise" spectrum and when there is well-expressed meso-scale variability the spectra are close to the dependence $k^{-2.3}$. The rms coherence spectra of CPP and OST spatial distributions are described well by a single parameter representing the mean wavelength above which there is reliable coherence. In the California Current there are two regimes of variability of the CPP and OST fields corresponding to the presence or absence of well-expressed transverse jets from the upwelling zone. Figures 7; references 10: 1 Russian, 9 Western.

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535.568.1:543.47

Altitudinal Change in Degree of Polarization of Radiation Propagating From Earth's Surface

18660147e Moscow ISSLEDOVANIYE ZEMLI IZ
KOSMOSA in Russian No 2, Mar-Apr 88
(manuscript received 20 Feb 86, after revision 23 Jul 87)
pp 52-57

[Article by V. M. Prokhorov and G. A. Lakhtanov,
Leningrad State University imeni A. A. Zhdanov]

[Abstract] There has been no adequate study of influence of the atmosphere on the polarization of radiation reflected from the underlying surface for different atmospheric altitudes. The problem is examined in the following formulation. The atmosphere is regarded as a medium consisting of two homogeneous layers having plane symmetry and bounded below by a homogeneous surface. The polarization of radiation incident from below on the interface of the layers occurs in a single scattering event in the lower layer and also upon reflection from the Earth's surface. (Secondary polarization of radiation reflected on the path from the surface to the interface is neglected.) The scattering planes for the polarized radiation reflected from the surface and scattered upward in the lower layer are assumed to coincide. Numerical modeling is used with this formulation for estimating the atmospheric contribution to the degree of polarization of the radiation ascending from the Earth's surface. The change in the degree of polarization was examined for three surface types: sod, desert sand and white quartz sand in the altitude range 0-5 km at a wavelength 492 nm. For example, in the case of a surface with a low albedo (sod) at definite altitudes with an azimuth 0° the degree of polarization decreases due to the depolarizing effect of the atmosphere. In all other cases this quantity increases with altitude. Figures 2; references 16: 6 Russian, 10 Western.

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551.521:629.78

Operational Method for Evaluating Geophysical Parameters of Ocean- Atmosphere System Using Data From Satellite Microwave Radiometry

18660147f Moscow ISSLEDOVANIYE ZEMLI IZ
KOSMOSA in Russian No 2, Mar-Apr 88
(manuscript received 10 Jun 86) pp 58-66

[Article by V. M. Polyakov and V. P. Savorskiy, Radio Engineering and Electronics Institute, USSR Academy of Sciences, Moscow]

[Abstract] A method was developed for routine determination of geophysical parameters using data from satellite microwave radiometers. The basis for the method is direct regression relations between changes in the radiometer output signals and variations of parameters of the atmosphere and ocean surface. A priori information on the spatial distributions of the sought-for parameters is used for determining these regression relations. (Such distributions of parameters were used earlier for determining the regression relations between increments of radiobrightness temperatures in the range 1.35 cm and variations of total moisture content and for other purposes.) In contrast to such earlier work, multivariate regression models were constructed for retrieving the values of geophysical parameters. The use of such regression relations for variations of geophysical parameters and changes in radiometer output signals precludes the need for reducing the radiometer readings to the scale of radiobrightness temperatures, considerably lessening the expenditures of computer time on the processing of experimental data in comparison with methods in which radiometric data expressed in radiobrightness temperatures are used. Examples of retrieval of the latitudinal distributions of integral atmospheric moisture content and ocean surface temperature are given. The errors are analyzed and the results are compared with data obtained as a result of solution of the inverse problem. The algorithm which is proposed can be applied in the stage of preliminary processing of satellite information in which radiometer scales are calibrated. Figures 4; references: 13 Russian.

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528.813:631.1

Allowance for Influence of Vegetation in Remote Microwave Radiometry of Terrestrial Surfaces

18660147g Moscow ISSLEDOVANIYE ZEMLI IZ
KOSMOSA in Russian No 2, Mar-Apr 88
(manuscript received 17 Apr 86) pp 67-72

[Article by A. A. Chukhlantsev and A. M. Shutko, Radio Engineering and Electronics Institute, USSR Academy of Sciences, Moscow]

[Abstract] Methods for taking into account the influence of vegetation in remote microwave radiometry are analyzed. In earlier studies a method was proposed for

taking into account the influence of the vegetation cover in single-wavelength measurements, which requires use of a priori information on the vegetation transfer coefficient. This method is now applied on a practical basis and the errors in determining the radiation characteristics of the Earth's surface are evaluated. Data are given from experimental investigations of the emissive characteristics of the soil under vegetation in single-wavelength measurements. In addition, a spectral radiometry method for remote determination of soil characteristics under vegetation is proposed and analyzed. It was found that when measurements are made in the decimeter wavelength range and with availability of a priori estimated data on the phytomass of the vegetation cover the error in determining soil brightness temperature does not exceed 10-20 K. This method makes it possible to measure soil moisture content under vegetation with a phytomass to 200-300 centners/hectare with a relative error no worse than 10-30 percent of the values obtained for unvegetated soil. The proposed spectral method does not require the availability of quantitative a priori information on the vegetation cover. When using this method the errors in determining the characteristics of soil under vegetation do not exceed the indicated errors for single-wavelength measurements. Figures 3; references 14: 6 Russian, 8 Western.

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528.852:681.3

Contrast Enhancement of Scanner Aerospace Images of Agricultural Fields

18660147h Moscow *ISSLEDOVANIYE ZEMLI IZ KOSMOSA* in Russian No 2, Mar-Apr 88
(manuscript received 4 Oct 86, after revision 17 Apr 87)
pp 73-82

[Article by A. S. Barykin and V. P. Popov, "AIUS-Agroresursy" All-Union Scientific Research Center, Moscow]

[Abstract] On aerospace scanner images the spectral brightness drops at the boundaries of agricultural fields and intrafield spectral brightness fluctuations are smoothed due to influence of the atmosphere and the peculiarities of image registry by the scanning radiometer. When classifying an image using the brightness criterion certain parts of the image can therefore be erroneously assigned to a class of agricultural crops having intermediate brightnesses relative to two adjacent fields. (The possible errors are illustrated in examples.) In this article it is shown that the distortions of spectral brightness along the edges of fields with different crops can be reduced by using algorithms for the mathematical filtering of images. A so-called "moving contrasting of digital images" algorithm is proposed which together with retrieval of the smoothed stepped brightness drops along field boundaries makes it possible to contrast intrafield brightness fluctuations without increasing their dynamic range. The method improves

the separability of classes and increases the accuracy in solving problems in phytopathological analysis of the state of agricultural crops. The mathematical and physical properties of the "moving contrasting operator" and its modifications are examined. Examples illustrating the processing of images with this operator are given. Figures 4; references: 2 Russian.

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528.711.1(202).007

Correction of Spatial-Temporal Distortions of Input of Photoimages Into Interactive Processing System

18660147i Moscow *ISSLEDOVANIYE ZEMLI IZ KOSMOSA* in Russian No 2, Mar-Apr 88
(manuscript received 1 Dec 86) pp 83-89

[Article by S. A. Bartalev and M. D. Breydo, "Les-proyekt" All-Union Aerial Photographic Forest Surveying Association, Moscow]

[Abstract] A method for correcting spatial-temporal distortions accompanying input of photoimages into an interactive processing system is proposed which makes it possible to form digital images invariant to input conditions into such a system and also gives experimental results making it possible to evaluate the effectiveness of use of the proposed method. The scheme for transformation of the photographic image can be represented in the form of successive connection of a number of functional modules described by certain transfer functions. These modules and the correction algorithm are fully outlined. The experimental apparatus and procedures are described. The method was used in automated interpretation of a black-and-white aerial photograph. The problem included determination of the mean diameter of projections of the crowns of bushes and the total number of bushes. A threshold algorithm was used for separating the images of bushes from the surrounding background. Accuracy was determined by comparison with surface data. The proposed method for correcting spatial distortions reduces the relative error in determining the required indices from 8 to 3 percent. When interpreting low-contrast features the influence of correction is significant and sometimes decisive. Figures 5; references: 4 Russian.

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Comparative Analysis of Methods for Compression of Spectrophotometric Information in Evaluating Hydrological Parameters

18660147j Moscow *ISSLEDOVANIYE ZEMLI IZ KOSMOSA* in Russian Mar-Apr 88
(manuscript received 12 Sep 88) pp 90-98

[Article by T. Farago, Central Meteorological Institute, Budapest]

[Abstract] One of the important problems in aerospace spectrophotometric measurements of radiation ascend

ing from the Earth's surface is the optimal choice of informative criteria. This problem arises, in particular, when it is necessary to compress a great volume of data when making measurements with a high spectral or spatial resolution. This article gives a solution of the problem of nonparametric evaluation of the interrelationship between the spectral brightness coefficient (as a vector predictor) and the concentrations of components in the water layer for the purpose of comparing some methods for rationalization of initial predictor space. These methods are illustrated by use of the results of radiation and hydrological measurements made in mesomorphous regions of Lake Ladoga. A study was made of three typical methods for the compression of spectrophotometric information, represented in the form of values of the spectral brightness coefficient in the problem of evaluating such parameters as the concentration of chlorophyll-a, total concentration of suspended matter, its mineral and organic components. The values of the parameters were obtained by contact measurements. Computations were made for various parts of the lake. For the most part similar results were obtained using different methods, but for water masses with an increased concentration of dissolved organic matter the level of predictability of the pertinent parameters was considerably reduced. The most advantageous methods are those using the values of the spectral brightness coefficient obtained at some fixed wavelengths. However, when investigating regions with water masses having different characteristics, allowance must be made for possible shifting of the informative wavelengths. References 55: 26 Russian, 29 Western.

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621.391.53.08

Analysis of Adaptive Algorithm for Detecting Boundaries on Low-Contrast Radar Images

18660147k Moscow ISSLEDOVANIYE ZEMLI IZ

KOSMOSA in Russian No 2, Mar-Apr 88

(manuscript received 25 Aug 86, after revision 28 May 87)
pp 99-103

[Article by L. G. Dorosinskiy and T. M. Lysenko, Ural Polytechnic Institute imeni S. M. Kirov, Sverdlovsk]

[Abstract] In radar sounding of the Earth's surface the features studied are sectors differing in effective surface scattering (scattering cross sections). These cross sections are typically assumed to be unknown and are evaluated by the maximum probability method. The images may contain a well-expressed boundary between individual regions with differing contrast. In automatic processing it is necessary to detect and evaluate the parameters of such boundaries. Algorithms are proposed which are used in solving the following problems: With what difference in scattering cross section is the reproduction of boundaries on a low-contrast image possible? What influence does a priori uncertainty of surface parameters have on the accuracy in constructing a boundary? What relationship is there between an optimal algorithm requiring excessive computer time and quasi-optimal algorithms whose application is technically feasible? The proposed algorithms make it possible to determine relatively smooth, nearly linear, boundaries, provided that the difference in scattering cross sections is 3-8 db, and also boundaries of arbitrary configuration if the difference in scattering cross sections exceeds 8 db. Figures 5; references: 3 Russian.

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**Glavkosmos Official Yu. P. Semenov Interviewed
On Development Of USSR Space Program**

*18660183a Kiev POD ZNAMENEM LENINIZMA in
Russian No 4, Feb 88 pp 74-78*

[Interview by POD ZNAMENEM LENINIZMA correspondents with Yuriy Pavlovich Semenov, director of projects for the development of manned craft for international space programs, Hero of Socialist Labor, recipient of the Lenin Prize and doctor of technical sciences, under the "Horizons of Science" rubric: "Steps Into Space"; first two paragraphs are source introduction. Passages in boldface as published]

[Text] **Humanity has begun counting down the fourth decade since that memorable day of 4 October 1957, when the earth's gravity was overcome for the first time and an artificial satellite was placed into a near-Earth orbit. Since then, an intensive exploitation of space has begun.**

Yu.P. Semenov, the director of projects for the development of manned craft for international space programs, Hero of Socialist Labor, recipient of the Lenin Prize and doctor of technical sciences, tells our correspondents about the first steps into space and about the prospects for the exploitation of interstellar space.

POD ZNAMENEM LENINIZMA: Yuriy Pavlovich, what sticks in your memory about the day of the launching of the world's first artificial satellite?

Yu. P. Semenov: The news about the launching of the first satellite found me in one of the design bureaus [KB], where I was doing my pre-diploma practical work. The work of this KB was associated with the work of S.P. Korolev's group and, therefore, we understood that this event could come to pass in the very near future. In addition, we already knew about S.P. Korolev's speech in the House of Unions' Hall of Columns on 17 September 1957, in connection with the 100th Anniversary of K.E. Tsiolkovskiy's birth. Korolev had said then that the first trial launches of artificial satellites could be expected in the very near future. Yet, nevertheless, the news literally surprised all of us.

Of course, we did not fully recognize back then the total significance of what had been accomplished and did not understand that this was the beginning of the birth of a whole branch of science, which would soon permeate into practically all fields of human endeavors and that, after some 15-20 years, many aspects of man's everyday existence would be incomplete or completely unthinkable without the services provided by space technology.

I do not think I would be wrong in saying that there were many people who were of the same frame of mind, perhaps everyone except for S.P. Korolev, who saw significantly farther than all of us.

POD ZNAMENEM LENINIZMA: How would you divide up the stages of the Soviet space research program? What would be characteristic of each of them?

Yu. P. Semenov: After the launching of the first satellite, two lines of the development of cosmonautics were outlined, as it were: investigation of near-Earth space using automatic craft and manned flights. Both of these lines are being further developed even up to the present day. For each of these trends, it is possible to note events which have defined entire stages of the development of cosmonautics. Yet, the division of the development of space technology into stages is, to a certain degree, of an arbitrary nature.

Thus, for example, it is possible to talk about the division of lunar research into stages: from the flight of an automated satellite to the moon to the automatic delivery of lunar soil to Earth. It is also possible to talk about the division into stages of the investigation of Venus and Mars and, finally, of Halley's Comet in the Vega Program and so on.

The manned flights also have their own stages. The launching of Yuriy Gagarin opened up the era of manned flights into outer space. Initially, this was only to obtain experience in a person working under space conditions. Later, on the Soyuz ships, the opportunity arose to solve more complicated problems, including interorbital maneuvers and the docking of ships in orbit. These flights prepared the opportunity for moving on to the next stage—the establishment of orbital stations.

The 1971 flight of the first Salyut orbital station presented the scientists and designers of space equipment with significantly greater opportunities and justifiably has been called the beginning of the stage of systematic investigation of outer space by man.

An important landmark in the orbital stations' flight program was the development of an automatic approach system using the Progress freight and refueling ships. The new approach system has made it possible to make more efficient use of the orbital stations—indeed, the opportunity arose to replenish the materials expended on them.

The last present-day stage is the launching of the Mir modular station.

POD ZNAMENEM LENINIZMA: After Yuriy Gagarin's flight, Soviet manned ships were constantly being improved. What were the goals of their developers at this time?

Yu. P. Semenov: The flight of the first spaceships were just to test the feasibility of manned flight into space. Indeed, we knew almost nothing about space back then. When, for example, Gagarin was sent up, on one console

was a special logic lock with an interlock of especially important commands: in case the cosmonaut suddenly developed mental problems after the launching.

Thus, the first flights were just to get the feel of the road.

The Soyuz ships were a significant improvement over the Vostok and Voskhod ships. They have a repeatedly usable propulsion system, systems for closing and docking with ships in space and a number of other systems which the preceding generations of ships did not have. This has made it possible to use the Soyuz ships for transportation to the Salyut and Mir orbital stations.

In contrast to the Vostok and Voskhod ships, the Soyuz has two habitation modules: the living quarters, where the crew works in orbit, and the descent module, which the people are in when the ship is placed into orbit by the launch vehicle and when they are returning from orbit and where they also control the ship's systems during maneuvering and docking.

Much has been done in the Soyuz to enhance the crew's safety: a special propulsion system has been provided to move the ship away from the booster in the event of an emergency, as well as two parachute systems—a main and a reserve—and a soft-landing engine, which is turned on immediately prior to landing, which substantially reduces the g-loads.

The return from orbit of the Soyuz ship's descent module is not done along a ballistic trajectory, such as was used for the return of the Vostok and Voskhod ships' descent modules, but rather, along a trajectory which uses a variable aerodynamic lift. This also reduces the g-loads which affect the cosmonaut and increases the accuracy of the landing.

The Soyuz ship has withstood the test of time. Over the more than 20-year period of its use, nearly 80 launches have been carried out—54 of them with cosmonauts on board.

The current modified version of the ship—the Soyuz TM—is the fourth generation of ships of this series on which extensive use has been made of computer equipment, on the basis of which the basic foundation for the '80's has been laid.

I do not think I would be wrong in saying that the Soyuz TM ship and its subsequent modified versions will be of service to people for many more years to come.

POD ZNAMENEM LENINIZMA: What have the Soviet orbital stations given to science and everyday life?

Yu. P. Semenov: The Salyut orbital stations were space laboratories, in which research was performed in the most diverse fields of human knowledge—both applied and basic.

A great deal of work was conducted, in particular, in the field of space medicine. Invaluable experience has been acquired in prolonged manned flight—from 24 days on the first Salyut orbital station to 237 days on the Salyut-7.

The orbital stations are an excellent testing ground for checking out newly designed equipment on behalf of prospective space systems.

A lot of work has been done in the materials science field and the obtaining of superpure materials and biological preparations under spaceflight conditions.

The enormous program of research on the Earth from outer space has produced a substantial economic effect. Suffice it to say that today nearly a thousand different economic organizations of this country are using the information obtained from space. Just through the state Priroda [Nature] center, more than a million pieces of varying information are passed on to them annually.

The Mir station is the new generation of orbital station. It is composed of special purpose modules. Such an approach sharply expands the opportunities for space research. A station can be developed, which can be built upon by docking additional modules.

The new technical solutions used on the station substantially increases its specific effectiveness.

Thus, the electromechanical attitude control actuators—the gyrodynes—make it possible to conserve a large amount of fuel, which significantly decreases the cargo flow on the 'Earth-Space' line.

Also efficient are other newly designed pieces of equipment, in particular, the new life-support systems: the electrolytic system for obtaining oxygen from water, the elimination of carbon monoxide gas using the regeneration system and so on.

Extensive use is being made of improved on-board computers. Permanent communications have been established on the 'Station-Earth' line and back via a relay satellite. Many of the on-board operations have been automated.

Naturally, more comfortable conditions have been created on the Mir station for the prolonged crew flights.

Cosmonaut Yu. Romanenko completed a flight on this station that lasted 326 days.

Briefly, the Mir station is the logical further development of the preceding stations. Our country's undisputed lead in this field is being maintained.

POD ZNAMENEM LENINIZMA: As is well known, the USA chose a different path from our country—flights into space using re-usable ships [space shuttles]. Please make a comparison of these two paths—ours and the Americans’.

Yu. P. Semenov: The outer space research programs in the USSR and the USA have always had their own specific features.

The first launchings of Soviet cosmonauts were made on the Vostok and Voskhod ships, while those of the Americans were on the Mercury ship. It is somewhat smaller than our ships and it was not possible to make an excursion into open space from it, as was done on a Voskhod by Aleksey Leonov.

The next stage was new ships, capable of carrying out complicated maneuvers in space: the Soyuz in the USSR and the Gemini in the USA.

In the USA, only manual approach and docking was tried out. We had developed and tested the automatic docking of manned ships, which was of important significance for supplying existing and future orbital stations. And, up to this time, the automatic space docking system exists only in the USSR.

Then, in the USA, a very interesting program was developed for a manned flight to the moon—the Apollo Program. This was a great victory for the American engineers. But, unfortunately, this program was not developed further.

During this time, we had shifted to the development of the Salyut orbital stations and subsequently were constantly improving them.

As is well known, the Skylab orbital station to which three expeditions were sent was also launched in the USA. But, for a number of reasons, in particular, I think, because of the complexity and the high cost of the Apollo manned ships, the use of this station turned out to be unprofitable and operations using it were terminated.

It is possible I am mistaken, but I get a strong impression that there is a lack of logic in the American space program, where each stage of the development of space technology would assume also the solution of a specified final goal and a natural progression.

With regard to our manned flight program, the improvement of the Salyut stations with the development of the automatic approach system using the Progress ships made it possible at this stage to obtain a very suitable instrument for the investigation of outer space.

The Mir station is the logical continuation of the development of orbital complexes, which places the work in orbit on a even higher level and lays the foundation for the orbital complexes of the future.

I would not want to compare our orbital complexes and the American space shuttles: each of them has its own areas of application.

The multiple-use ‘Shuttle’ ship developed in the USA, naturally, has many advantages, but its flight time is not long and that makes it an unsuitable method for conducting space research in comparison with the long-term orbital stations.

But, at the same time, the following generation of orbital complexes with broadly developed industrial production will require the transportation to the Earth of significant amounts of produced items and also the delivery into orbit of large-scale units for the repair and renovation of the station. Here, single-use transportation systems will not suffice. This is why in our program also, in the future (when the need will arise), provision will be made for the use of space shuttles, along with the single-use systems as long as these still remain the most economically justifiable means.

POD ZNAMENEM LENINIZMA: How do you picture the orbital complexes of the future?

Yu. P. Semenov: The orbital complexes of the future will be a unified system of large-scale structures connected to one another.

Contact with the Earth will be maintained by freight and passenger transportation ships, including space shuttles. The complex will be made up of specialized scientific research laboratories, comfortable living quarters, greenhouses, powerful power supply units, fueling stations, repair shops and construction platforms for the manufacture and assembly of structural components, including the assembly, testing and preparation of craft for interplanetary flights and their return to Earth.

Such an orbital complex, even in the initial stages of its construction, will make it possible on a nation-wide scale to monitor the state of the atmosphere and the plantings of agricultural crops, to detect the locations of forest fires and to increase substantially the efficiency of prospecting for and estimations of mineral resources, and so on.

In the future, it may be possible to place under man’s control the complex processes which occur in the earth’s atmosphere.

In order to solve such multipronged and large-scale economic problems, the future orbital complex will have to have significant dimensions. It will consist of large-scale structures which will be deployed directly in space.

POD ZNAMENEM LENINIZMA: What is your evaluation of the state of space technologies?

Yu. P. Semenov: Today, the term ‘space technology’ is understood to mean two directions: the development of manufacturing processes and the technical means for

assembly, erection, preventive maintenance and repair and renovation work in open space for the purpose of constructing large-scale space complexes (solar power plants, powerful radio telescopes, platforms and so on) and work associated with the science of space materials.

Our scientists and designers, having such excellent 'space proving grounds' as the Salyut orbital stations, and now the Mir station, have at their disposal enormous opportunities. Over the last 10 years, a great deal has been done in the field of space technology, biotechnology and materials science, but there is still a lot more to be done.

A large number of manufacturing experiments have been performed on the orbital stations, which have shown that, under weightlessness conditions, it is possible to obtain materials with unique properties.

For example, On the Salyut-7 station, using the Tavriya device, superpure interferon, cell cultures and protein compounds were produced. Obtained in the Splav [Alloy], Kristall [Crystal] and Korund [Corundum] devices were semiconductor materials with a high degree of structural perfection, a more even distribution of the admixtures in the crystal volume and a much lower (by a factor of 10-15) concentration of defects.

These results served as the basis for the development and manufacture of the next generation of manufacturing devices—Ruchey [Stream] and Potok [Flow] for obtaining biological preparations and Korund-1M for testing basic manufacturing processes for obtaining semiconductor materials such as silicon and germanium, indium antimonide, zinc oxide, cadmium sulfate, and so on.

The testing of basic manufacturing processes makes it possible to refine the requirements for equipment for industrial production of materials in space, to evaluate the product outcome and its reproducibility and to establish the production cost of materials and the profitability of space production.

All this instills the hope that, in the not too distant future, there will be specialized manufacturing modules, in which will begin the exploitation of the industrial production of materials in space for the national economy.

Serious advances have been achieved by our engineers and scientists in ensuring the normal functioning of complicated orbital complexes through the conducting of planned preventive maintenance and repair and renovation work both inside and outside the station. Particular note must be taken of the accumulated experience in working in open outer space on the docking of large-size loads, the deployment of antennas and the building up of solar battery panels and the work with girders of large size using all-purpose welding outfits.

All this creates the prerequisites for the transition in the near future to the assembly of large structures and to large-scale operations in space.

POD ZNAMENEM LENINIZMA: How have the scientists of our republic participated in space research?

Yu. P. Semenov: The Ukraine's numerous scientific groups are making an invaluable contribution to the development of manned ships and stations, being co-developers of these complexes.

The scientists of the UkSSR Academy of Sciences and the republic's higher education institutes are playing an important role in solving materials science problems of space equipment. For example, the methods and equipment of the Elektrotopograf [Electrotopograph] for the study of the kinetics of the breakdown of structural materials and coatings under the integrated action of space factors were developed in the UkSSR Academy of Sciences' Physics Institute.

The Kharkov Polytechnical Institute's scientists developed the basic aspects of the methods for accelerating the tests of construction materials in open space and the equipment of the Mikrodeformator for conducting the tests.

The scientists of the UkSSR Academy of Sciences' Electric Welding Institute imeni Ye.O. Paton are playing a special role in the development of space equipment and technology. In due course, at the initiative of academicians S.P. Korolev and B.Ye. Paton, the Vulkan system was developed and tested in space. Tried out on this system were the technological processes for electron-beam, arc and ion-plasma welding of construction materials.

Starting with the year 1979, experiments have been continuing on the orbital stations on the Ispartel-80 [Vaporizer], Ispartel-M and Yantar equipment. Processes have been tested for applying temperature-controlling, protective and technological coatings under orbital flight conditions.

An "All-purpose Manual Tool", a portable electron-beam set, has been developed and tested under open space conditions. Using this instrument, it is possible to cut, weld and solder structures and apply coatings to the external surface of the manned complex.

At the present time, the Electric Welding Institute imeni Ye.O. Paton, in extensive cooperation with other scientific groups, is conducting work on the development of standardized components for the construction of large-scale structures in space. It was started in 1986, when the first converted hinged-arm truss with a length of 15 meters was tested in the integrated Mayak [Beacon]

experiment. The results of the test of the converted truss made it possible to formulate the basic technical requirements for repeatedly deployed solar batteries of future orbital complexes.

A qualitatively new level of materials science and engineering support will be required for the construction and operation of such complexes. The scientists of the republic's Academy of Sciences and higher educational institutions, together with industry workers, should play a decisive role in the solution of many of these problems.

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Future Space Projects Discussed at Moscow Space Forum

*18660136 Riga NAUKA I TEKHNIKA in Russian
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[Article by Tamara Breus, Candidate of Physicomathematical Sciences: "Space: Ideas for the Future"]

[Text] The yield of fundamental and applied research in cosmonautics can be increased by international cooperation. One thing is clear to the attentive observer: life on our planet is being affected by space research. Life is changing irreversibly due to space technologies, the practical use of which is enormous. Today there are orbital telescopes, while tomorrow there will be lunar bases; today there is space communications, and tomorrow there will be rocket-powered passenger aircraft. Several organizations have been created especially by world society to discuss questions on the study and development of space. These are the Committee on Investigation and Utilization of Space (COSPAR), the International Astronautical Federation (IAF), the International Astronomical Union (IAU) and a number of others. "But in recent years," says the director of the Space Research Institute of the USSR Academy of Sciences Academician R. Z. Sagdeyev, "a strong feeling has developed that some unofficial forms of cooperation are also necessary, which would make it possible to build a bridge from purely professional space activity to new ideas, which our planet is now in dire need of. The problems of space development require even broader thinking not only from scientific and technical positions, but from philosophical, ideological and humanitarian aspects." Thus arose the suggestion to create an international forum "Cooperation in Space in the Name of Peace on Earth" in Moscow, devoted to the 30th anniversary of the space era of mankind, the basis of which was laid by the USSR's first launch of an artificial earth satellite. The idea was originated by a group of scientists from Hungary, Holland, the USSR, the United States, West Germany, France and a number of other countries, headed by R. Z. Sagdeyev. A total of 890 persons participated in the work of the forum and more than half

of them represented more than 30 foreign countries. The forum opened the unusually broad panorama of a "storm of the Universe" by terrestrial science.

Around the Earth

One of the important goals remains the attaining of knowledge of circumterrestrial space, primarily of its plasma envelope. Our planet is seemingly clothed in a "supersonic" plasma flux, originating on the sun—the "solar wind." This concept was quite recently considered fantasy. Science is now involved in the unique, essentially fantastic properties of this "wind." Many experiments were devoted to study of the interaction of the solar wind and the Earth's magnetic field and it is related directly not only to the "state of being" of circumterrestrial space, but to the course of life on the planet as well. A project was conceived, which could become the direct successor to the broad international structure that formed during the course of research on Halley's comet. It has been proposed that approximately 10 satellites of different countries be launched—10 datum points of a unified international measuring network. The satellites will be located at altitudes of hundreds to 1.5 million kilometers. It is planned to launch one of the Soviet spacecraft—a "Prognoz" of a new design—to a point located on an Earth-Sun straight line, where Earth's gravity is compensated for by the gravity of our star. This will be the most distant datum point of the network. Operating according to a unified program, the satellites will make possible a three-dimensional concept of what is really occurring in the Earth's plasma envelope. It will also apparently be possible to substantiate the suggestion that the interactions of the electric and magnetic fields in the plasma pave the way for specific mechanisms which result in circulation of the upper atmosphere and possibly affect the formation of earth's weather.

Extra-Atmospheric Astronomy

The planned research encompasses practically the entire range of electromagnetic radiation—from radio waves to gamma waves. The greatest attention will apparently be devoted to X-radiation. The main task of X-ray astronomy is diagnosis of the hot cosmic plasma. This will permit the study of the nature and dynamics of explosive processes in various objects and investigation of the properties of matter under extreme physical conditions, which cannot be achieved in Earth-based laboratories. X-radiation occurs in the "cauldron" of atomic and nuclear transformations, which occur at temperatures of at least 500,000 degrees. One can recall for comparison that visible sunlight is emitted by a surface heated to "only" 5,500 degrees. Thus, the "hottest" and "most vigorous" processes in the Universe can be observed in the X-ray band. One of the latest sensations was the explosion of a star in the adjacent galaxy of the Large Magellanic Cloud. A so-called supernova occurred, which was distinguished by colossal brightness, and Earth-based telescopes of the Southern Hemisphere trapped an increase of light from the supernova flare on

23 February 1987 and it is still visible with the unaided eye. (Such an event was last observed 400 years ago.) The glowing envelope, which formed upon explosion of the star, was initially so dense that X-ray and gamma-ray fluxes, which lost their energy as if "sticking" in it, was not discharged to the outside. But since the envelope is speeding away from the exploded star in all directions at colossal speed, it gradually becomes ever "more transparent." And thus on 10 August 1987, the Rentgen Observatory, installed onboard the "Kvant" module docked to the orbital station Mir, recorded hard X-radiation from the supernova. The Japanese satellite Ginga (Milky Way) also trapped this radiation within 5 days. A seminar was held within the forum, which was devoted to discussion of the results. Scientists of the USSR, England, Holland, West Germany and the European Space Agency participated in development of the Rentgen Space Observatory. Another project of an orbital observatory—Granat—is being implemented through the joint efforts of Soviet and French scientists. The observatory was conceived as a combination of instruments for conducting detailed research over the broadest energy range from 3 kiloelectron volts to 2,000 kiloelectron volts. We recall that the American satellite observatory "Einstein", which delivered a mass of "fresh news," frequently quite unexpected, operated in the soft energy band from 0.1 to 4 kiloelectron volts. The design of the new generation X-ray observatory "Spektr-Roentgen-Gamma" was also discussed. It was generally felt that its implementation will permit a significant step forward in understanding the physical properties of different classes of astronomical objects and of identifying many, incompletely understood physical phenomena in the Universe. Among them are the newborn stars in close binary systems, the magnetosphere of pulsars, the inner regions of the cores of galaxies, the remains of supernova and sources of gamma flares. The use of new generation telescopes of unprecedented sensitivity in the extra-atmospheric observatory, which will provide a structure of the images of observable objects in the X-ray band and which will permit high-quality spectroscopy, will permit a significant advance in reaching these goals. The results will contribute to development of new large X-ray observatories, launch of which is planned before the end of the century. Development of a ground-space radio system is also planned, which will be equivalent in its resolution to a gigantic radio telescope with antenna diameter of almost 1 million kilometers. The radio system—it is called an interferometer—will consist of two space antennas operating synchronously, injected into very elongated orbits, and of the world's largest ground-based radio telescopes. And the greater the distance between the antennas, the higher will be the angular resolution of the entire system, that is, its acuteness of vision is the capability to resolve close objects emitting radio waves at huge distances.

Planetary Investigations

They will remain one of the basic directions of space activity for the next few years and right up to the end of the century. Considerable restructuring [perestroyka] of

the main goals is planned. The efforts are concentrated primarily toward study of Mars. The Soviet Union has proposed a broad step-by-step program, the final goal of which is to deliver a sample of Martian soil to Earth by the year 2000. It is planned to carry out a detailed cartographic survey of the surface of the planet during the first step with the aim of selecting the interesting regions for subsequent investigations and touchdown of "landing modules." Balloons will also be introduced into the Martian atmosphere along with the modules. Self-propelled vehicles—Martian rovers, capable of covering distances of at first tens and later hundreds and thousands of kilometers, will then be delivered to the planet. The speed of the Martian rover will be determined by available power, and will also be dependent on the terrain and on the scientific program along the itinerary. Delivery of Martian soil to Earth is the most complicated element of the program. Different versions are being worked out. The returning spacecraft should be quarantined in all cases in order to exclude infection of Earth by extraterrestrial organisms, regardless of how low the probability. Analysis of the soil in Earth laboratories will apparently permit clear conclusions with respect to life on Mars (now or in the past). The experience of the American Viking spacecraft showed that it is extremely difficult for automatic vehicles, despite their perfection, to conduct these investigations directly on Mars. And there is yet another aspect. Delivery of soil will essentially become a model of a subsequent, manned voyage on the Earth-Mars-Earth route.

Flight to Mars

Approximately 50 persons from the more than 200 who have been in space participated in the discussion. The discussions show that there are no completely insurmountable technical difficulties. Planning this flight is no more complicated at the present stage of development of space technology than were lunar expeditions in their time, compared to the first flight of man into space. Another thing is whether man is capable of such a prolonged stay in space—the flight to Mars will require approximately 2.5 years. "The volume of our knowledge," noted the director of the Institute of Medical-Biological Problems Academician O. G. Gazonko, "now permits human flight in space at an acceptable level of risk. But at the same time, it is important to emphasize that we still do not know everything about the reaction of the human organism to the effects of space and of space flight. The astronaut's muscles lose mass during prolonged flights. The bone tissue also changes, which is related to losses of calcium salts. Is this hazardous? Not yet. But I feel that these losses may affect the strength of the skeleton as the duration of space flights increases. When man is in orbit for a long time, the organism's resistance to infections is lowered. Since the problem exists, we should investigate it so as to essentially eliminate the danger of disease. Another thing is ensuring the radiation safety of the crew. Flights are now made on routes that are below the earth's radiation belts and do not present any obvious hazard to the cosmonauts. But,

thinking about future interplanetary communications, one must imagine what effect heavy cosmic particles will have. Biological experiments are being conducted in this direction on spacecraft flying beyond the earth's magnetosphere. Large groups of cosmonauts will participate in future space flights. The problem of psychological compatibility will become acute in this regard. Finally, the duration of the flight will be considerably dependent on solution of life-support problems. In the final analysis, we should talk about creation of self-contained ecological systems onboard the spacecraft which are capable of existing for a rather long period on the basis of closed circulation of substances, with their own self-regulating and self-controlling mechanisms, as occurs in the Earth's biosphere. I am very optimistic and hopeful about the idea of human flight to Mars and I hope that people will achieve this. Nevertheless, despite the fact that we have achieved serious successes in development of space, the volume of our knowledge is inadequate to give a scientifically substantiated serious answer to the question of whether man can fly to Mars."

And even so, we have now achieved the more than 300-day boundary of man's stay in space. On the whole, one gains the impression that man can adapt satisfactorily to prolonged effects of weightlessness and at the end of prolonged flights, he can adapt to Earth's gravity. The use of artificial gravity during flight as a preventive measure is very probable in the future. K. E. Tsiolkovskiy wrote about this in the early part of this century. Introduction of new powerful rocket carriers will permit discussion of developing a radiation shelter with sufficiently thick shielding onboard a manned interplanetary spacecraft. In short, there are no unresolvable problems. However, taking into account that we are talking about man and about his health and safety, each new step into space should be weighed scrupulously and we should rely on the most careful detailed study, newly obtained data and primarily on previous experience. We should not overlook anything, including the long-range consequences of space flights.

Other Problems

Space science is yielding and with every year will yield ever greater practical results. These are further development of telecommunications and of the meteorological network and other applications for the needs of man. Space technology could play a very sensitive monitoring role in checking global ecological processes. This monitoring will yield a reliable forecast of what the Earth, its atmosphere and climate can expect in the future and will permit measures to be worked out to maintain conditions of a normal life on the planet. The topic "commercial space" will acquire ever greater timeliness. During the past few years, the Soviet Union has offered a number of services to all interested countries, which could be offered on a broad international basis—launching of foreign satellites by Soviet rockets, making available technological equipment on satellites and on orbital stations for manufacture of various types of materials

and medicines, and photography of the territories of countries according to their corresponding requests. It is felt that there is a great future for commercial cosmonautics. Regardless of what was discussed at the international meeting of scientists, the need to combine the efforts of all countries was constantly emphasized. Effective development of space is now unthinkable without this. Holding an International Space Year in 1992 may be one of the specific manifestations of space cooperation, as was indicated in the adopted declaration of the forum participants. It would include coordinated activity in cosmonautics in 1992 and coordination of planning for future projects beyond this century. The International Space Year would encompass joint activity on study of global changes of Earth's environment, of the planets, of the moon and of the heliosphere, research in astrophysics, radio astronomy and solar physics, industrialization of space and the use of space technology for education and medicine.

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6521

Soviet-French Commission Discusses Upcoming Cooperative Space Missions

18660122 Moscow IZVESTIYA in Russian
23 Jan 88 p 4

[Excerpt] The 22nd session of the permanent mixed Soviet-French ("large") commission on economic and scientific-technical cooperation took place in Moscow on 20-21 January.

The two sides noted with satisfaction that Soviet-French cooperation has been developing productively in the field of the study and use of outer space for peaceful purposes. Emphasis was placed in this connection on the special importance of carrying out this year joint space research projects which are now being prepared. These projects are "Aragats," the second joint manned flight, which was agreed upon at the top level; "Gamma-1" and "Granat," which are intended for mapping galactic and extragalactic sources of gamma radiation and x-radiation; and "Phobos," aimed at studying the planet Mars, its satellite Phobos, the sun and the interplanetary medium. The commission hailed the successful progress of cooperation in line with the project "Interbol" for the study of near-Earth space, and also the inclusion in the program of cooperation of a project called "Alissa" for lidar probing of the Earth's atmosphere.

The Soviet delegation was headed by K.F. Katushev, USSR minister of foreign economic relations.

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Soviet Union To Launch Indian Resources Satellite

18660121 Moscow PRAVDA in Russian 9 Jan 88 p 5

[Article by V. Korovikov]

[Text] New Delhi, 8 January. "Our national plan of space research is aimed at solving many terrestrial problems of our country," stated Professor U. R. Rao, chairman of the State Commission on Space and Space Research. "It is planned to carry out many programs in the new year, including ones involving minerals prospecting and study of the condition of forest and soil covers, sowings and water resources. A new Indian satellite for remote sensing, the 'IRS-1,' will play a major role in this work. This spacecraft, which weighs a thousand kilograms, is equipped with many highly-perfected instruments. It was developed by Indian specialists in Bangalore. It is now ready and will be sent to the Soviet Union within a few days. Plans call for the satellite to be launched into orbit from the Baykonur Cosmodrome on a Soviet rocket, at the end of March."

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Possibilities for Coordination of Soviet and U.S. Planetary Programs

18660123 Tallinn SOVETSKAYA ESTONIYA in Russian 6 Jan 88 p 4

[Article by Yu. Zaytsev, department head, USSR Academy of Sciences' Institute of Space Research]

[Abstract] The article reviews the recent progress of Soviet-U.S. cooperation in research on the solar system, particularly the planets Mars and Venus. Objectives and problems of Mars probes which are planned for the early 1990s are surveyed, and the author comments at some length on results of the first conference of the Soviet-American working group for research on the solar system, which took place in Moscow from 7 to 13 December.

Information on long-range research programs for the period up to the year 2000 was exchanged at this conference, the author relates. Creation of a Soviet-American scientific group and subgroups to coordinate cooperation in the study of Mars was proposed. The subgroups would be assigned special tasks, including development of an engineering model of Mars. Another proposal involved a Soviet aerostat station which is to be used in a project called "Mars-94." This proposal called for joint study of the possibility of transmitting telemetry information from this station to the U.S. "Mars Observer" spacecraft.

The author relates that the two sides exchanged maps and television and radar pictures of the surface of Mars, the Martian moon Phobos, and the planet Venus which

had been obtained with the aid of Soviet and American spacecraft. Plans which were approved call for Soviet geological and photographic maps of Venus, maps of the reflectivity of this planet's surface, and digital copies of these maps on magnetic tape to be turned over to American researchers in 1988-1989. The American representatives agreed to share scientific information on Venus which is to be obtained with the aid of the U.S. "Magellan" spacecraft. Another proposal called for organizing a scientific group to prepare and carry out experiments with the USSR's "Phobos" spacecraft, which is scheduled for launching later this year. This group would include representatives of France, West Germany and Hungary. The purpose of one of the proposed experiments is to determine Phobos' position in space more precisely, with the aid of radio telescopes on Earth.

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Soviet Official Discusses Policy on Sale of Space Photography

18660124 Moscow TRUD in Russian 20 Jan 88 p 4

[Article by V. Belykh]

[Excerpt] The foreign-trade association "Soyuzkarta" of the USSR Council of Ministers' Main Administration for Geodesy and Cartography has concluded an agreement with Australia's geodetic service to photograph this country's entire territory from space.

"This step is a rather risky one at first glance," said V. Yashchenko, head of this administration. "After all, the Americans and the French have had a monopoly in this field on the international market. But Soviet scientists have developed a unique camera with a resolving power of 5 meters."

"How are orders for 'space photographs' taken in 'Soyuzkarta'?"

"Any state institution, firm or private citizen of a foreign country can order a 'space photograph' from us. These orders are included in the flight program of the next satellite.

"A single color photograph and negative from 'Soyuzkarta' costs 1,000 dollars, on the average.

"Firms of the Federal Republic of Germany, Italy, the Netherlands and 10 other countries are now among our clients. Brazil's national coffee institute has requested us to photograph an area of 100,000 square kilometers. When this order has been filled, 'Soyuzkarta' will receive a million dollars. Argentina has addressed a similar request to us. Firms of Finland, the United States and France recently offered their services as intermediaries."

"In the U.S. press, particularly the newspapers HERALD TRIBUNE and NEW YORK TIMES, it has been assumed that the sale by a Soviet firm of photographs taken from space might be conducive to breaches of military security."

"I frankly admit that attempts to place such orders have been made, both on the state level and using private firms as a cover. We therefore offer 'space photographs' only of client-countries' territories."

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Preparations for 'Phobos' Mission Discussed at International Conference

18660125 Moscow GUDOK in Russian 30 Jan 88 p 1

[Text] An international scientific-technical conference on the space project "Phobos" completed its work on 29 January at the USSR Academy of Sciences' Institute of Space Research. As is known, this project is aimed at studying Mars, its moon Phobos, interplanetary space and the sun with the aid of unmanned space stations.

Taking part in the meeting were scientists and specialists of the USSR, Austria, Bulgaria, Hungary, the German Democratic Republic, Ireland, Poland, the United States, Finland, France, the Czechoslovak Socialist Republic, Switzerland, Sweden and the European Space Agency. The progress of work on preparing this major space project, which is entering its final stage, was examined at the conference. Final operations for checking research equipment developed in countries that are taking part in the project are now being carried out at the Research and Testing Center imeni Babakin. This equipment will be installed on board the two Soviet interplanetary stations.

The participants of the international conference expressed satisfaction that work on carrying out the project is proceeding according to the schedule, which calls for the "Phobos" spacecraft to be launched in July of this year.

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Memorandum Signed on Soviet-Afghan Space Mission

18660126 Moscow SOTSIALISTICHESKAYA INDUSTRIYA in Russian 12 Feb 88 p 3

[Article by V. Lagovskiy]

[Excerpt] A memorandum in regard to preparation and execution in 1988 of a mission of a joint Soviet-Afghan crew on board the orbiting research complex "Mir" was

signed yesterday in the USSR Main Administration for Development and Use of Space Technology for the Economy and Scientific Research (Glavkosmos).

The memorandum was signed on the Soviet side by A. Dunayev, head of USSR Glavkosmos, and on the Afghan side by M.A. Watanjar, member of the Politburo of the Central Committee of the People's Democratic Party of Afghanistan and minister of communications.

The candidates for the flight will be named today. A competent medical commission is to select the two most worthy candidates from a group of eight.

"M.S. Gorbachev's announcement of the beginning of a Soviet troop withdrawal from Afghanistan is now a focus of the whole world's attention," said A. Dunayev at the ceremony. "The present memorandum will contribute to the strengthening of friendship and good-neighborliness and promote the development of Afghanistan's economy."

A flight program has been set and agreement reached on a list of experiments. At the request of Afghan specialists, there will be two main directions of research. The first will be study of the Earth's surface from space—remote sensing and photographing of individual regions. The purpose of this is to render specific assistance in solving economic problems of the country and to advance this direction of research. The second direction will be medical-biological experiments. Reactions of an organism in conditions of adaptation to space flight will be studied.

The Afghan cosmonauts will take over from our Bulgarian friends in August.

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USSR Launches Indian Resources Satellite IRS-1A

18660174 Vilnius SOVETSKAYA LITVA in Russian 18 Mar 88 p 3

[TASS Report]

[Text] An Indian satellite, IRS-1A, was launched with a "Vostok" launch rocket from the Soviet Union on 17 March 1988.

The satellite is intended for obtaining, with the aid of electrooptical equipment, routine information for the purpose of studying Earth natural resources.

Work on preparing and conducting the launch of the Indian satellite was done by the USSR Main Administration for Development and Use of Space Technology

for the Economy and Scientific Research in line with a commercial agreement concluded between the all-Union association "Litsenzintorg" and India's space research organization.

The IRS-1A satellite was placed into a solar synchronous orbit with the parameters: maximum distance from Earth's surface—917 kilometers; minimum distance from Earth's surface—863 kilometers; period of revolution—102.7 minutes; orbit inclination—99.01 degrees.

According to telemetry information, the apparatus installed on the satellite is functioning normally.

Control of the flight of the IRS-1A satellite is being effected at present by the USSR's "Medvezhi Ozera" tracking station, which is located in suburban Moscow, and by the Indian control center in the city of Bangalore.

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Indian Satellite Launch Described as First Commercial Launch by USSR

18660175 Moscow TRUD in Russian 18 Mar 88 p 3

[Article by V. Golovachev, special correspondent at the Flight Control Center]

[Excerpt] The first satellite to be launched on a commercial basis by the Soviet Union was placed into a near-Earth orbit yesterday. What does 'commercial basis' mean? It means that the client paid a certain sum for the launching. The client in this case was the Indian Space Research Organization. The Indian side paid the USSR 7.5 million rubles, offsetting a portion of our expenditures.

The Indian satellite has a mass of 970 kilograms.

This spacecraft is intended for studying the Indian subcontinent—its natural resources, the condition of forest and soil covers, plantings, water resources and fishing conditions. On board the satellite are three photographic and television cameras, which scan areas of the Earth's surface 74 and 148 kilometers wide.

One of the most remarkable things about the satellite is that it was not launched in the usual direction for spacecraft. That is to say, Soviet spaceships and satellites fly from west to east, as a rule (they are launched from Kazakhstan in the direction of the Pacific Ocean), while the IRS-1A was launched in a southerly direction, toward the Indian Ocean. In other words, the direction of flight of spacecraft usually coincides with the direction of the Earth's rotation, but the situation with the Indian satellite is different; to an observer on the ground, it moves to the west. This plan—which, it must be noted, is more complicated from the standpoint of consumption of fuel by the rocket—was selected in accordance with a

request of the Indian specialists. This unusual direction of movement of the satellite creates more favorable conditions for probing Indian territory.

The satellite's planned service life is about three years.

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USSR Exhibits Space Equipment at Conference in Switzerland

18660176 Yerevan KOMMUNIST in Russian
6 Feb 88 p 3

[Excerpt] Space freight has been sent from Moscow to Switzerland in motor vehicles of the "Sovtransavto" organization. Soviet participants of the second international conference on questions of the commercial and industrial use of space prepared a considerable number of exhibits for shipment. This conference will be held in Montreux from February 21 to 25.

An exhibition of space equipment which will accompany the forum's work is the first commercial exhibition of this kind in which Soviet organizations are taking part. Representatives of the USSR—the USSR Main Administration for Development and Use of Space Technology for the Economy and Scientific Research, the "Soyuzkarta" and "Litsenzintorg" organizations, the USSR State Committee on Hydrometeorology and the USSR Academy of Sciences—will show representatives of major Western firms Soviet capabilities for studying the Earth's resources and monitoring their use from space, and for producing materials and alloys in conditions of orbital flight.

Services involving the launching of foreign satellites on Soviet rockets and use of the station "Mir" in environmental protection and for producing materials in space are among the advanced commercial proposals which Soviet organizations have made to foreign partners.

A space photograph of Lake Geneva on which areas of pollution are readily visible is hardly likely to escape the attention of visitors of the exhibition. The use of space methods for studying the Earth's surface makes it easier to obtain extremely important environmental-protection data, allows such data to be made more reliable and lowers the cost of such work in the end.

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V.A. Bogdanov Named Head of 'Morsvyazsputnik'
18660177 Moscow VODNYI TRANSPORT
17 Mar 88 p 3

[Text] The USSR Council of Ministers has appointed Valeriy Antonovich Bogdanov chairman of the USSR Ministry of the Merchant Fleet's all-Union electronavigation and satellite-communications association "Morsvyazsputnik".

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Press Conference on Latest 'Mir' Mission; Work on Shuttle Spacecraft Nearing Completion
18660178 Moscow KRASNAYA ZVEZDA in Russian
21 Jan 88 p 3

[Abstract] The article is a report of a press conference which was held in the USSR Ministry of Foreign Affairs on 20 January. This conference was devoted to results of the mission of cosmonauts Yu. Romanenko, A. Laveykin, A. Aleksandrov and A. Levchenko on board the orbiting station "Mir". Remarks made by the cosmonauts and other participants in the conference are quoted or summarized.

Romanenko reviewed the main events of his 326-day mission. Immediately after returning to Earth, he and Aleksandrov experienced consequences of their pro-

longed stays in zero gravity, Romanenko recalled. The state of their health was comparatively good, however, and their readaptation to terrestrial conditions proceeded fairly rapidly. A. Grigoryev, deputy director of the Institute of Medical-Biological Problems, and other specialists who took part in medical support of the mission praised Romanenko's performance of conditioning exercises on board "Mir". They reported that postflight examinations of the cosmonaut revealed no reactions of his organism to zero gravity which were qualitatively new or as yet unknown. In Romanenko's case, changes since the completion of his mission of record duration have been even less pronounced than those observed after a number of shorter missions.

Levchenko and A. Dunayev, head of the USSR Main Administration for Development and Use of Space Technology for the Economy and Scientific Research, responded to a question regarding results of an airplane piloting experiment which Levchenko performed immediately after landing, and the target date for launching a Soviet reusable spacecraft. Levchenko reported that results of the piloting experiment were the same as those obtained before the space mission. Dunayev said that work on a reusable space system is nearing completion, but that no launching plans will be announced until this system has undergone a complete series of trials.

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