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10 February 1986

USSR Report

SPACE

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USSR REPORT

SPACE

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MANNED MISSION HIGHLIGHTS

TASS REPORTS COSMONAUTS CONTINUING WORK ON 'SALYUT-7'

Moscow IZVESTIYA in Russian 2 Oct 85 p 1

[TASS Report]

[Text] Flight Control Center, 1 October. The flight of the orbiting complex "Salyut-7"--"Soyuz T-14," which is manned by cosmonauts Vasyutin, Savinykh, and Volkov, is continuing.

Today's program of work for the crew includes routine maintenance measures on individual systems of the station, visual observations of the earth's surface, and technical experiments. The commander and the cosmonaut-researcher also will undergo a medical examination.

After completing the program of joint research involving the work of five cosmonauts on board the "Salyut-7" station, Vladimir Vasyutin, Viktor Savinykh, and Aleksandr Volkov rested on Saturday and Sunday. Visits with their families were held in the course of several sessions of radio and television communications.

The flight of the orbiting complex "Salyut-7"--"Soyuz T-14" is proceeding normally. Its orbit parameters at the present time are: maximum distance from earth's surface--358 kilometers; minimum distance from earth's surface--337 kilometers; period of revolution--91.3 minutes; inclination--51.6 degrees.

The cosmonauts are in good health and are feeling well.

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MANNED MISSION HIGHLIGHTS

TASS REPORTS DOCKING OF 'COSMOS-1686' WITH 'SALYUT-7'

Moscow IZVESTIYA in Russian 3 Oct 85 p 1

[TASS Report]

[Text] The docking of the satellite "Cosmos-1686" with the manned orbiting complex "Salyut-7"--"Soyuz T-14" was accomplished on 2 October 1985, at 1316 hours Moscow time.

Mutual search, rendezvous and docking were executed automatically and were monitored by the Flight Control Center and the crew of the orbiting complex--cosmonauts Vasyutin, Savinykh, and Volkov. The satellite docked with the station on the side where its adapter module is located.

The flight program of the manned complex "Salyut-7"--"Soyuz T-14"--"Cosmos-1686" calls for testing equipment, aggregates and structural elements of the satellite; further perfecting of methods for controlling multiple-component orbiting complexes with large dimensions and masses; and conducting scientific research and experiments.

The "Cosmos-1686" satellite delivered to the station equipment, instruments, and various cargo items that are needed to ensure the further functioning of the manned complex.

According to the crew's reports and telemetry data, the onboard systems of the scientific research complex "Salyut-7"--"Soyuz T-14"--"Cosmos-1686" are functioning normally.

Cosmonauts Vladimir Vasyutin, Viktor Savinykh, and Aleksandr Volkov are feeling well.

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MANNED MISSION HIGHLIGHTS

TECHNICAL EXPERIMENTS, MEDICAL STUDIES ON ORBITAL COMPLEX

Moscow IZVESTIYA in Russian 5 Oct 85 p 1

[TASS Report]

[Text] Flight Control Center, 4 October. Vladimir Vasyutin, Viktor Savinykh, and Aleksandr Volkov are continuing to carry out planned work on board the scientific research complex "Salyut-7"--"Soyuz T-14"--"Cosmos-1686."

In the days just past, the crew has been doing maintenance work on individual onboard systems, and performing technical experiments for the purpose of studying characteristics of the atmosphere around the manned complex.

Yesterday the crew's flight engineer, who has now spent 4 months in conditions of zero gravity, underwent a comprehensive examination of his cardiovascular system.

The results of this monitored medical experiment confirmed that the condition of Viktor Savinykh's health is good, and that he is feeling well.

Today's program includes technological, geophysical, and technical experiments, a medical examination of the commander and the cosmonaut-researcher, and taking of motion pictures of the crew's work.

In line with the program of space materials science, an experiment will be performed in the technological unit "Pion" for the purpose of further studying processes of heat and mass transfer in liquids in conditions of microgravitation.

During the day the cosmonauts will make visual observations and take photographs of the waters of the Black and Caspian Seas, and of individual regions of the republics of Central Asia.

According to the crew's reports and telemetry data, the work in near-earth orbit is proceeding according to the mission's schedule. The cosmonauts are feeling well.

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MANNED MISSION HIGHLIGHTS

ROLE OF 'COSMOS-1686,' ABSENCE OF RETURN VEHICLE

Moscow PRAVDA in Russian 6 Oct 85 p 6

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

[Abstract] The article reports briefly on the role of the "Cosmos-1686" spaceship-satellite as part of the orbiting complex linked with the "Salyut-7" scientific station.

Describing the impressive size of the "Cosmos-1686," the author notes that it is nearly as large as the "Salyut-7" station, which weighs 18,900 kilograms and is 15 meters long and 4.15 meters in diameter at its widest part. With the "Soyuz" transport ship, which reportedly weighs 6,850 kilograms and has interior space of 10 cubic meters, the entire complex of three linked spacecraft is said to weigh nearly 50 tons and to be about 35 meters long.

It is reported that cosmonaut-researcher Aleksandr Volkov has begun setting up equipment in the part of the "Cosmos-1686" that usually serves as a reentry vehicle, but will not on the present mission. On this mission, the spaceship-satellite is said to be performing the role mainly of a scientific laboratory; specialists reportedly refer to it as a "module version." "Cosmos-1686" is said to have delivered about 5 tons of dry cargo to the complex, including large-size scientific equipment which is installed in its scientific module.

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MANNED MISSION HIGHLIGHTS

COSMONAUTS PERFORM VISUAL OBSERVATIONS, PHOTOGRAPHY

Moscow IZVESTIYA in Russian 9 Oct 85 p 1

[TASS Report]

[Text] Flight Control Center, 8 October. The space mission of Vladimir Vasyutin, Viktor Savinykh, and Aleksandr Volkov on board the manned complex "Salyut-7"--"Soyuz T-14"--"Cosmos-1686" is continuing.

Today a substantial portion of the crew's working time is reserved for geophysical experiments that are being performed in line with an extensive program for study of the earth's natural resources and the environment. Plans call for visual observations and photographing of territory of the Soviet Union in the middle and southern latitudes, and of individual regions of the waters of the world's oceans.

The day's schedule calls also for operations for reactivating the satellite "Cosmos-1686," routine checks of scientific apparatus, space-biology experiments, another series of measurements of parameters of the atmosphere directly surrounding the complex, and physical exercises.

According to results of telemetry measurements and reports from orbit, the flight of the scientific research complex is proceeding normally.

The condition of the health of cosmonauts Vasyutin, Savinykh, and Volkov is good, and they are feeling well.

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MANNED MISSION HIGHLIGHTS

EXPERIMENT BEGUN FOR COLLECTING METEORITIC MATTER ON 'SALYUT-7'

Moscow IZVESTIYA in Russian 12 Oct 85 p 1

[TASS Report]

[Text] Flight Control Center, 11 October. The orbital flight of cosmonauts Vasyutin, Savinykh, and Volkov is continuing.

A substantial place in the crew's program of work is reserved for comprehensive studies of the earth's surface, including visual observations, photography and spectrometry. Geophysical studies were made of the Lake Balkhash area, North Kazakhstan, the Aral and Caspian Seas, and the Caucasus today.

Another series of measurements of flows of high-energy electrons and positrons, using the "Mariya" instrument, has been made for the purpose of studying mechanisms of the generation of these particles in near-earth space.

In line with the medical monitoring plan, the cosmonauts have undergone an examination which involved measurement of the bioelectric activity of the heart. Measurements of body mass also have been made, as well as an evaluation of the condition of muscles that are not exerted much in zero gravity. The first stage of an experiment for gathering meteoritic matter in space was completed yesterday. This experiment is being conducted with the aid of apparatus developed by Soviet and French specialists. Vladimir Dzhanibekov and Viktor Savinykh installed this apparatus on the outer surface of the station during their egress into open space.

According to results of telemetry measurements and reports from orbit, the flight of the scientific research complex "Salyut-7"--"Soyuz T-14"--"Cosmos-1686" is proceeding normally.

All three cosmonauts are healthy and feeling well.

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MANNED MISSION HIGHLIGHTS

ATMOSPHERIC, BIOLOGICAL RESEARCH CONTINUES ON 'SALYUT-7'

Moscow IZVESTIYA in Russian 23 Oct 85 p 1

[TASS Report]

[Text] Flight Control Center, 22 October. The flight of the orbiting complex "Salyut-7"--"Soyuz T-14"--"Cosmos-1686," which is manned by Vladimir Vasyutin, Viktor Savinykh, and Aleksandr Volkov, is continuing.

A large portion of the crew's working time in the past days has been devoted to photographing the earth's surface and studying the atmosphere.

Today the crew will perform several more series of photography of land surface and the sea using the MKF-6M multizonal camera, the KATE-140 wide-format apparatus, and various spectrometry apparatus.

The purpose of an experiment called "Aerozol'," which also is planned for today, is to obtain new information on noctilucent clouds and on the gas composition of the atmosphere and its optical and spectral characteristics.

A series of experiments with gathering of meteorite material in near-earth space is being completed. This work is being done with the aid of equipment which was developed jointly by scientists and specialists of the Soviet Union and France, and which is mounted on the outer surface of the station.

Biological studies are continuing on board the orbiting complex, inside the space hothouses "Oazis" and "Vazon" and in the unit "Biogravistat." Sprouts of pepper, onion, and lettuce have been chosen as objects of study.

During periods of communication, the crew is reporting that the program of work in orbit is proceeding according to the mission schedule. The cosmonauts are feeling well.

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MANNED MISSION HIGHLIGHTS

MAINTENANCE WORK, MEDICAL EXAMS ON 'SALYUT-7'

Moscow IZVESTIYA in Russian 30 Oct 85 p 1

[TASS Report]

[Text] Flight Control Center, 29 October. Cosmonauts Vladimir Vasyutin, Viktor Savinykh, and Aleksandr Volkov are continuing their mission on board the orbiting complex "Salyut-7"--"Soyuz T-14"--"Cosmos-1686."

During the days just past, the cosmonauts conducted experiments for measuring characteristics of the atmosphere around the complex, made routine checks of instruments and apparatus, and did preventive maintenance work with onboard systems and equipment.

Visual observations and photographing of various areas of land surface and the waters of the world's oceans were continued.

Today's program includes medical checkups, work with technical documents, and preparation of scientific apparatus and instruments for upcoming experiments. Studies will be made of reactions of the circulatory system of the crew's flight engineer to measure amounts of physical exertion as he exercises on the ergometer bike. This examination will be conducted for the purpose of evaluating the working fitness of this cosmonaut, who has been in conditions of zero gravity for more than 4 and 1/2 months.

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

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MANNED MISSION HIGHLIGHTS

ATMOSPHERIC, BOTANICAL RESEARCH ON 'SALYUT-7'

Moscow IZVESTIYA in Russian 2 Nov 85 p 2

[TASS Report]

[Text] Flight Control Center, 1 November. Vladimir Vasyutin and Aleksandr Volkov have been in orbital flight for a month and a half, while flight engineer Viktor Savinykh has been working in space for 149 days.

During the days just past, the cosmonauts performed another series of experiments for determining spectral and optical characteristics of the earth's atmosphere, and they conducted a number of medical and biochemical studies.

Today's program includes biological experiments with higher plants that are being cultivated on board the orbiting complex, visual observations and photography of individual regions of the waters of the world's oceans, and physical exercises.

Leisure time has also been scheduled.

Cosmonauts Vasyutin, Savinykh, and Volkov are continuing to carry out the designated flight program.

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MANNED MISSION HIGHLIGHTS

'COSMOS-1686' USED TO MAINTAIN 'SALYUT-7' ORIENTATION

Moscow PRAVDA in Russian 5 Nov 85 p 3

[Article by A. Tarasov, correspondent at the Space Flight Control Center]

[Abstract] The article reports on how visual observations and photography are consuming a large amount of the working time of the crew on the "Salyut-7" orbiting station. Conversations between crew members and operators at the Flight Control Center are recorded. They were debating whether orientation of the orbiting complex would be terminated for a day which was scheduled mostly for rest and relaxation. The control center complied with the cosmonauts' wishes that orientation be maintained during the off day, since they might want to do some extra work, and, as cosmonaut Aleksandr Volkov put it, orientation promotes a "normal psychological climate." It is explained that orientation of the orbiting complex is now easier and more reliable thanks to the powerful and economical engine of the "Cosmos-1686" spaceship which is docked with the station. It is said that "Cosmos-1686" can maintain orientation for a whole week at a time.

The article describes two examples of visual-observation and photography tasks that are included in the mission's flight log, a copy of which was shown to the author at the control center. One involved a series of observations and photography of fault zones in the Tyan-Shan Mountains, and the other called for study of possibilities of locating buried irrigation systems of ancient civilizations of Central Asia.

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MANNED MISSION HIGHLIGHTS

COSMONAUTS CONTINUE EXPERIMENTS ABOARD 'SALYUT-7'

Moscow PRAVDA in Russian 13 Nov 85 p 1

[TASS Report]

[Text] Flight Control Center, 12 November. The space mission of Vladimir Vasyutin, Viktor Savinykh, and Aleksandr Volkov is continuing on board the manned complex "Salyut-7"--"Soyuz T-14"--"Cosmos-1686."

In the past days the cosmonauts performed a series of technical experiments which included, in particular, evaluation of the effectiveness of solar batteries, perfecting new instruments, and determining dynamic characteristics of the complex orbiting system consisting of a scientific station and two ships.

With the aid of apparatus that was delivered by the "Cosmos-1686" spaceship-satellite, the crew performed a number of geophysical studies for the purpose of investigating flows and spectra of charged particles, and for obtaining information on noctilucent clouds and on the gaseous composition of the atmosphere and its spectral and optical characteristics.

An examination of the cardiovascular system of the flight engineer, who has been in orbital flight for 160 days, was conducted yesterday. Results of the examination showed that the condition of Viktor Savinykh's health is good.

Today a large part of the crew's working time is being devoted to studies in the program for studying the environment. Experiments are planned for determining more precisely the dynamic model of upper layers of the atmosphere, as well as visual observations, photography and spectrometry of individual regions of our country and of the waters of the world's oceans.

The onboard systems of the orbiting complex are functioning normally.

Cosmonauts Vasyutin, Savinykh, and Volkov are continuing to carry out the mission program.

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MANNED MISSION HIGHLIGHTS

MEDICAL EXAMS OF COSMONAUTS PERFORMED

Moscow IZVESTIYA in Russian 16 Nov 85 p 3

[TASS Report]

[Text] Flight Control Center, 15 November. Cosmonauts Vasyutin, Savinykh, and Volkov are continuing their planned work on board the orbiting complex "Salyut-7"--"Soyuz T-14"--"Cosmos-1686."

The flight program during the past days included medical-biological studies; geophysical, astrophysical and technical experiments; and routine checks of systems and scientific apparatus of the station.

A comprehensive examination of the cosmonauts was conducted in line with the medical monitoring plan. In particular, studies were made of the condition of their cardiovascular systems both at rest and with simulation of hydrostatic pressure. The latter was accomplished with the aid of the "Chibis" pneumatic vacuum suit, in which a flow of blood to the lower part of the body is produced by means of a barometric pressure differential, thereby simulating terrestrial gravity. An experiment also was performed for the purpose of evaluating the dynamics of change in the composition of the gas medium in the complex's living compartments.

Today the crew will continue geophysical studies aimed at obtaining additional information on the earth's natural resources and the condition of the environment. The cosmonauts will work on classifying results of experiments, and they will engage in physical exercises with the ergometer bike and on the running track. Time is also set aside for rest.

The onboard systems of the manned complex are functioning normally.

The work in near-earth orbit is proceeding in line with the designated program.

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MANNED MISSION HIGHLIGHTS

COSMONAUTS' FLIGHT TERMINATED DUE TO ILLNESS OF VASYUTIN

Moscow IZVESTIYA in Russian 22 Nov 85 p 1

[TASS Report]

[Text] On 21 November 1985, at 1331 hours Moscow time, the crew of the orbiting scientific research complex "Salyut-7"--"Soyuz T-14"--"Cosmos-1686," consisting of cosmonauts Vladimir Vasyutin, Viktor Savinykh, and Aleksandr Volkov, returned to earth.

The reentry vehicle of the "Soyuz T-14" ship made a landing in the designated area, 180 kilometers southeast of the city of Dzhezkazgan.

In the course of a 2-month flight, the crew carried out a large amount of work on studying the earth's surface and atmosphere, as well as astrophysical, technological and technical experiments and medical-biological research.

The prolonged flight of the cosmonauts on board the orbiting complex was terminated in connection with Vladimir Vasyutin's falling ill and the need to hospitalize him.

V.P. Savinykh and A.A. Volkov are feeling well.

The orbiting complex "Salyut-7"--"Cosmos-1686" is continuing to fly in the automatic mode.

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MANNED MISSION HIGHLIGHTS

COMMENT ON DECISION TO TERMINATE FLIGHT

Moscow IZVESTIYA in Russian 22 Nov 85 p 6

[Article by B. Konovalov, correspondent at the Flight Control Center]

[Abstract] The article reports on the conditions of the return of the crew of the orbiting complex "Salyut-7"--"Soyuz T-14"--"Cosmos-1686" to earth. This reportedly marked the first time that a mission had to be cut short due to reasons of health of a crew member. The crew commander, Vladimir Vasyutin, became ill, and the mission directors, after weighing all possibilities, decided that the crew should return so that Vasyutin could be hospitalized. Vasyutin and cosmonaut-researcher A. Volkov had been in flight for 65 days, and flight engineer Viktor Savinykh had been in flight for 168 days. Savinykh assumed the role of flight commander of the "Soyuz T-14" ship for the return to earth. It is mentioned that the cosmonaut training program takes account of such contingencies, and that either the flight engineer or the cosmonaut-researcher could have assumed the commander's role.

Conversations are recorded between the crew and flight director V. Ryumin and V. Shatalov, director of cosmonaut training, during the separation from the "Salyut-7" station and preparations for reentry. Shatalov reported on conditions in the landing area, where there was a light snow cover and partial cloudiness.

A photograph is given showing the three cosmonauts seated in their space suits after the landing.

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MANNED MISSION HIGHLIGHTS

FURTHER COMMENTS ON VASYUTIN'S ILLNESS AND TERMINATION OF MISSION

Moscow PRAVDA in Russian 23 Nov 85 p 3

[Article by V. Gubarev]

[Abstract] The article is a summary of the latest mission on the "Salyut-7" orbiting station, reviewing what was accomplished by two crews before the mission had to be cut short due to the illness of Vladimir Vasyutin, commander of the second crew of the mission.

The author recalls highlights of the extraordinary recovery mission performed by Vladimir Dzhanibekov and Viktor Savinykh, and of the scheduled research program carried out by the second crew of Vasyutin, Savinykh, Georgiy Grechko, and Aleksandr Volkov. Special attention is devoted to the contributions of Savinykh and Grechko to the success of the research program. The author then relates the following about the circumstances of Vasyutin's illness:

"Vladimir Vasyutin's illness complicated the mission. At first he himself as well as his comrades in space and on the ground hoped that the attacks of pain could be overcome. But outer space is outer space. In general, the medical specialists had to put Vasyutin on the first 'space sick leave.' Work that was planned for three was done by Savinykh and Volkov. And considering that the experience of Aleksandr was still rather limited, most of the burden fell on Viktor. It was a really complex mission that fell on his shoulders, to be precise, a double mission--one with Vladimir Dzhanibekov, and another one with Vasyutin and Volkov. Moreover, Savinykh had to assume the functions of crew commander. It was during the landing, one of the most crucial operations, that he officially became the crew commander. It was his voice that we heard when the 'Soyuz T-14' ship was returning to earth."

The author goes on to relate that although the mission had to be cut short, everything that was planned up to the point of termination was overfulfilled, and the results were impressive. He notes that in particular, 16 million square kilometers of the earth's surface were photographed, and astrophysical, technological and technical experiments were performed regularly, as well as medical-biological studies. The 85 scientific instruments on board the station were operated during 400 sessions of scientific observations. It is noted that the crew was able to deactivate the "Salyut-7"--"Cosmos-1686" complex reliably, without hurrying, and the complex is continuing to fly in the automatic mode.

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MANNED MISSION HIGHLIGHTS

HEAD OF AERIAL PHOTOGRAPHY INSTITUTE PRAISES WORK OF SAVINYKH

Moscow PRAVDA in Russian 22 Nov 85 p 4

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

[Abstract] The article is a brief report from the mission control center as cosmonauts Vasyutin, Savinykh, and Volkov were returning to earth from the orbiting station "Salyut-7." Commenting briefly on the success of the research program, the author noted that Viktor Savinykh had a hand in practically all of the experiments that were conducted. It is mentioned that Savinykh is a graduate of the Moscow Institute of Engineers of Geodesy, Aerial Photography and Cartography, whose president, Vasiliy Dmitriyevich Bolshakov, was present at the mission control center. Bolshakov was asked if he communicated with Savinykh in the course of the mission. He replied:

"Naturally. Professional interests required this. But I should point out that Viktor Petrovich, as the crew's flight engineer, was not working only in the interests of our branch of knowledge. But we were pleased that he responded to our requests willingly and with a thorough understanding of what was required. In particular, we asked him to continue observations of the Aral Sea which were begun as far back as on 'Salyut-5.' The condition of the Aral Sea is a matter of serious concern. Comparison of the past and present data will make it possible to draw important conclusions relative to the future of this region. Among new tasks, we asked him to pay special attention to the Talas-Fergana fracture, and to the condition of Lake Issyk-Kul'. Stated briefly, he worked actively in the area of mapping and the ecology."

Bolshakov also noted that although Savinykh does not work at the institute, he visits it whenever he can.

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MANNED MISSION HIGHLIGHTS

SYRIANS BEGIN COSMONAUT TRAINING

Moscow PRAVDA in Russian 17 Nov 85 p 4

[TASS Report]

[Text] In accordance with an existing agreement, two citizens of the Syrian Arab Republic have begun training at the Cosmonaut Training Center imeni Gagarin for a joint Soviet-Syrian space flight.

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SPACE SCIENCES

WORLD'S LARGEST CAMERA FOR SATELLITE OBSERVATION INSTALLED AT ZVENIGOROD

Moscow LENINSKOYE ZNAMYA in Russian 17 Oct 85 p 4

[Article by M. Rogozhnikov]

[Excerpt] The world's largest camera for observing artificial earth satellites has been installed at the Zvenigorod station of the USSR Academy of Sciences' Astronomical Council.

"Small deviations of geostationary satellites from their prescribed orbits sometimes occur," said Aleksandr Markovich Lodzinskiy, head of the satellite observation laboratory. "At regular intervals, it is necessary to give them a 'push'--to correct their orbits."

The photographing of satellites from earth is still the most precise and accurate method for determining their coordinates.

The D. Maksutov-Ye. Sobolev camera was installed near Zvenigorod for this purpose. This unique instrument was assembled at the Krasnogorsk Mechanical Plant.

A.M. Lodzinskiy and I went inside the building where the camera is installed. This gigantic structure is many meters in diameter, weighs 25 tons, and rests upon three leg supports, each of which has a sectional diameter of about 10 centimeters. These legs rest in turn upon three steel balls. This allows slight changes to be made in the unit's position.

On clear, starry nights, two huge motor-driven doors swing open, and the camera is aimed at constellations. In addition to the two axes of rotation that any telescope has--an hour axis and a declination axis--this instrument also has an orbital axis. It makes it possible to track satellites flying in any direction.

"There are about 250,000 stars in the catalogue of stars," said Valeriy Osipenko, a junior science associate of the laboratory. "It gives their coordinates. There are also charts of the stars in the sky. By matching these charts with photographs, we obtain a precise 'fix' on artificial satellites and determine their positions at the moment they are photographed.

"Why is the camera so large?"

"The dimensions give our camera a focal length of 75 centimeters," explained A.M. Lodzinskiy. "This is greater than that of the American Baker-Nunn camera, which is the second largest camera of this kind, and it permits more precise determination of space stations' coordinates. We are also conducting scientific studies of celestial mechanics here."

The Maksutov-Sobolev camera also makes it possible to study "depressions" and "hills" in space.

"When the fuel supply of an automatic satellite runs out, the satellite continues to move in orbit," Lodzinskiy continued. "And it becomes a most interesting object for purposes of observing terrestrial gravitation. A gravitational 'depression' in space corresponds to mountain rock masses or iron-ore deposits on earth. In such places, gravitation is greater and a satellite's orbit is distorted. And depressions on earth, the oceans, for example, produce the opposite phenomenon. A satellite 'jumps' over them, so to speak."

Since no corrections are made in the orbits of satellites that have ceased to operate, they gradually accumulate by the dozens in huge gravitational "depressions" in space--places of maximum gravitation--which are up to 500 kilometers in diameter. As these satellite-clusters fly over the planet, they can be used to judge gravitational anomalies of the earth. Still other questions of celestial mechanics can be solved with the aid of the camera; effects which the sun, moon and other natural space objects produce on artificial satellites can be recorded, for example.

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SPACE SCIENCES

'SPACE' PAVILION AT THE ALL-UNION EXHIBITION OF ACHIEVEMENTS IN THE NATIONAL ECONOMY

Moscow ZEMLYA I VSELENNAYA in Russian No 3, May-Jun 85 pp 95-100

[Article by A. N. Kozub]

[Text] Space and scientific-technical progress. Such is the principal theme of an exhibit in the "Space" pavilion at the All-Union Exhibition of Achievements in the National Economy. This is a fasciating exhibit, occupying an area equal to an entire hectare, demonstrating the successes of the Soviet Union in study of the universe. The exploitation of space, each new step in this exploitation, evoke enormous interest among visitors to the exhibit. In the pavilion it is possible to see models of artificial earth satellites, automatic interplanetary stations and spaceships and "visit" aboard an orbital station. The models are constructed at natural size; these are precise duplicates of space vehicles.

Module of SSRT solar radio telescope antenna consisting of 256 parabolic reflectors with cruciform layout. The SSRT radio telescope is situated in the Sayan foothills and is used in solar observations in the centimeter range of radio waves.

The objective of the exhibit is not only to display space equipment, but also, in easily understood form, to tell about the principal stages of space research in our country, about the scientific directions forming on their basis, which have considerably broadened and to a great extent have changed our ideas concerning the earth and its atmosphere, the sun and planets of the solar system, stars and structure of the universe.

The exhibit occupied four halls. Visitors gained familiarity with the exhibit beginning with the entrance hall. It is devoted to the history of development of rocket-space technology in the USSR. The exhibit stands display the work of the illustrious band of scientists and designers who were pioneers in Soviet rocket construction. Here, to be sure, there is an exhibit of the work of K. E. Tsiolkovskiy, who laid the basis of modern cosmonautics and rocket technology.

A place of honor was devoted to materials dealing with Academician S. P. Korolev, the chief designer of rocket-space systems. This name is inseparably associated with outstanding achievements in cosmonautics: the development and launching of the first artificial earth satellites, the first flight of man into space, the first launchings of space vehicles toward the planets of the solar system.

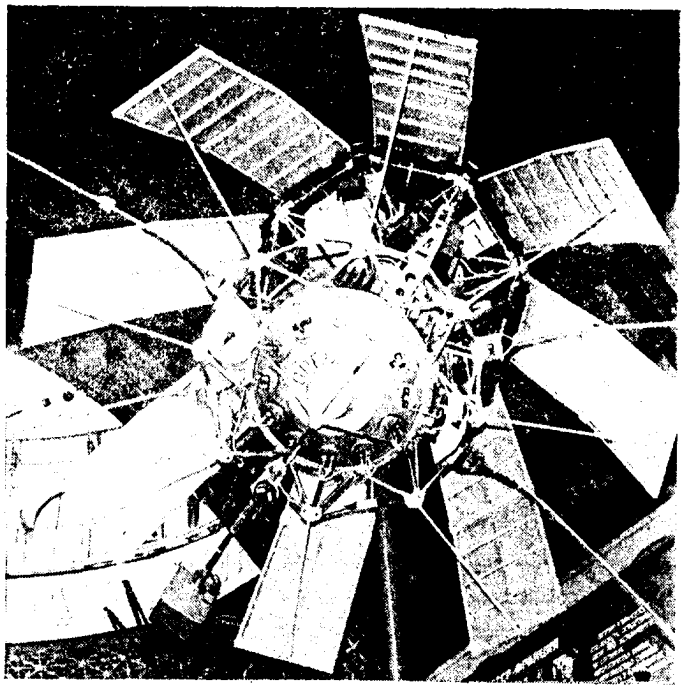
Also presented here are the portraits and works of scientists, engineers and designers who have made an especially valuable contribution to the exploration of space: Yu. V. Kondratyuk, F. A. Tsander, N. I. Tikhomirov, M. K. Tikhonravov, V. P. Glushko, M. K. Yangel, A. M. Isayev, M. V. Keldysh... The exhibit in the hall is completed by the first artificial earth satellite.

The next two halls exhibit samples of space apparatus. First the visitors see the surprising diversity of different types of automatic vehicles for the exploration of space: rockets, satellites and interplanetary stations. Here each exhibit represents a landmark in the development of Soviet cosmonautics. Only a few years after the launching of the first satellite, complex scientific satellites began to appear: "Elektron," "Prognoz," "Proton," "Cosmos" -- intended for study of circumterrestrial space. Among visitors a great popularity is enjoyed by the section telling of the practical use of space technology. Shown here are communication satellites, "Molniya-2," "Ekran" and "Gorizont," the navigation satellite "Cosmos-1000" and the "Meteor-2" meteorological satellite.

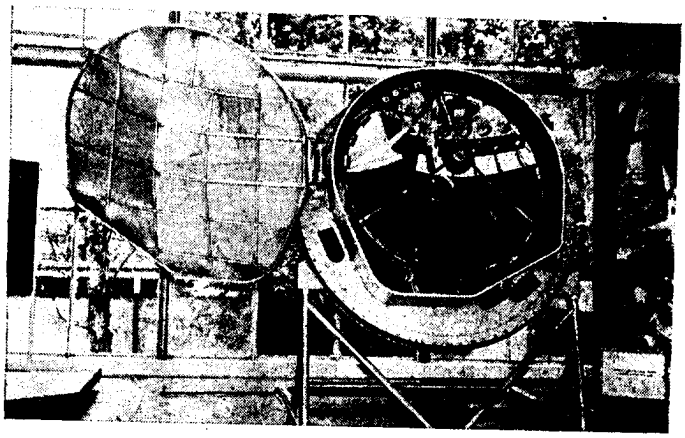
The materials in the next section show how automatic vehicles have been used in studying the moon and other celestial bodies. The pavilion shows the "Lunokhod-2," used in making prolonged scientific investigations on the lunar surface. The flights of the interplanetary stations "Luna-16," "Luna-20" and "Luna-24" ensured the return of samples of lunar ground to the earth. The "Luna-24" (included in the exhibit), by means of a drill rig of a new type, was able to take ground from a depth of two meters.

There are interesting exhibits familiarizing visitors with the surprising worlds of other planets. Most important here is the "Venera-4" station, the first to transmit information on the parameters of the Venusian atmosphere, and the descent module of the "Venera-7" station, making the first soft landing on the surface of the "blue planet." The space vehicles "Venera-9" and "Venera-13" (its descent module is exhibited in the section), second-generation stations, were intended for the more thorough study of this planet, the closest to us. They transmitted unique images of its surface at the landing site of the descent modules and carried out comprehensive investigations of both the planet itself and space surrounding it. Alongside it sits the

"Mars-3" station, which became an artificial satellite of Mars and transmitted information concerning this planet from orbit.

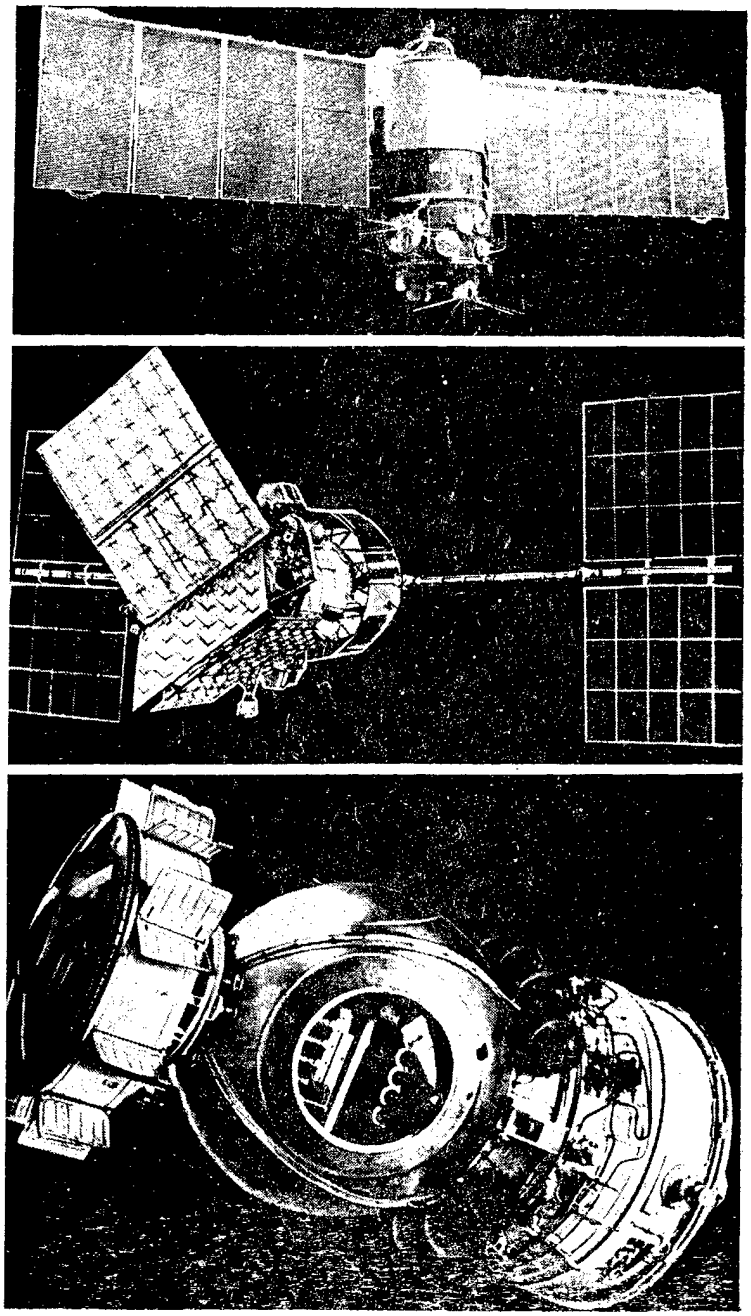


"Oreol-3" satellite used for Soviet-French experiments for studying nature of auroras ("Arkad" project).



BST-1M on-board submillimeter telescope. It was mounted on the "Salyut-6" orbital station for carrying out astrophysical research.

The descent module of this station for the first time made a soft landing on the Martian surface.



Top: One of the exhibits in the pavilion: the space weather explorer, the satellite "Meteor-2." It ensures collection of meteorological information and its transmission to the earth.
Middle: "Ekran" satellite for direct TV broadcasting. The high power of its onboard relay apparatus makes it possible to send TV programs to simple surface collective-use receivers in remote regions of Siberia and the Far North.
Bottom: The results of investigations on specialized biological satellites are of great importance. The "Cosmos-782" satellite was launched for studying the effect exerted on living organisms by spaceflight factors. Specialists of these countries participated in developing the experiments: USSR, Hungary, Poland, Romania, Czechoslovakia, United States, France.

The "Space-National Economy" section displays the protective suit worn by a welder. It was developed on the basis of spacesuits.

Aboard an orbital station cosmonauts use a bicycle-type ergometer for physical exercises. Such an ergometer is now a necessary component in a system for preventing the harmful influence of weightlessness on the human body.

With each passing year space research is being carried out by an increasing number of countries. This is made clear in the next section of the hall. The internationalization of space research and the mastery of space has found its expression in the "Intercosmos" program. The program is being implemented by satellites of the "Intercosmos" series, by "Vertikal" geophysical rockets, by the M-100, MR-12 meteorological rockets and by manned space vehicles. The exhibit makes it possible to become familiar with this technology. In addition to the mentioned exhibits, visitors can see the "Oreol" and "Oreol-3" satellites by means of which Soviet-French experiments were carried out for studying the nature of auroras.

The exposition is supplemented by a section of photographic materials telling about the joint scientific research of Soviet scientists and the scientists of the socialist cooperation countries, as well as France, India, United

States and Sweden. There is a display of scientific instrumentation developed and constructed abroad for carrying out joint experiments.

The third hall of the pavilion is occupied by the "Manned Space Flight" exhibit. It is difficult to decide which displays are the most interesting. The attention of visitors is attracted by absolutely everything: spaceships of different types and an orbital station, flight suits, spacesuits for emergence into open space, medical support and many other things. The first display is one for the famed "Vostok" spaceship together with the last stage of the carrier rocket: it was used in 1961 by Yu. A. Gagarin in making the world's first orbital space flight.

At the center of the hall is one of the most interesting and impressive displays in the exhibition: the "Salyut-7"-"Soyuz"-"Progress" orbital scientific research complex. The multiton construction with a length of 30 meters rests on light supports and seems like it is in space flight. There is always a line at this exhibit because vistors are able to go inside the station itself. Using a special ladder they go up into the station, examine its compartments and control panels and become familiarized with scientific instruments and life support systems. Among the facilities available to cosmonauts were a shower, air ionizer, video magnetic recorder and many others.

One of the sections of the hall is devoted to Soviet space heroes. Two enormous stands hold the portraits of all Soviet cosmonauts who have made flights on the ships "Vostok," "Voskhod" and "Soyuz" and have worked aboard the "Salyut" stations. In showcases it is possible to see different objects which the cosmonauts have used in orbital flights.

Special mention must be made of a special exhibit entitled "His Stellar Hour." It was opened in 1984. On 9 March 1984 Yuriy Alekseyevich would be 50 years old. The commemorative exhibit contains photographs telling of the life, studies and work of the world's first cosmonaut. Here is a photograph of Gagarin as a student at the Saratov Industrial Technical School. And there he is at the Orenburg Military Aviation School, from which he successfully graduated in 1957. March 1960 -- Yu. A. Gagarin becomes part of the cosmonaut detachment... And finally, in a new photograph, he walks smiling and happy through the fields near Saratov -- April 1961...The next photographs tell of the professional and social activity of Yu. A. Gagarin after the flight. We see him amongst the delegates of the 22d Congress CPSU and at the rostrum at the 25th Komsomol Congress and at a lecture at the Military Air Academy imeni N. Ye. Zhukovskiy. There is an interesting photograph of Yuriy Alekseyevich during his work as deputy head of the Cosmonaut Training Center. The stands also tell of the journeys of Yu. A. Gagarin through our country and abroad. He visited 30 countries and more than 300 cities of the world named Yuriy Gagarin an honorary citizen. This exhibit ends with a display of photographs showing him amidst relatives and friends -- with his parents Anna Timofeyevna and Aleksey Ivanovich, his wife Valentina Ivanovna and his daughters Lena and Galeya.

The attention of visitors is also drawn to the specialized exhibit "Orbits of Cooperation," telling of the activity of international crews. The first such flight was made on 2 March 1978. Then a citizen of Czechoslovakia was sent on a week-long space expedition as a member of an international crew. Later cosmonauts of Poland, East Germany, Bulgaria, Hungary, Vietnam, Cuba, Mongolia,

Romania and France worked together with our cosmonauts. The Soviet-Indian space flight made last year was the eleventh international expedition.

The photo stands tell about the preparation of cosmonauts for launchings, their presence at the Baykonur cosmodrome, space flights, meetings of cosmonauts on the ground and their journeys through our country and abroad. Also represented are the results of joint investigations. Showcases display scientific instrumentation used in space for implementing unique experiments. The fourth hall of the pavilion was opened in the autumn of 1984. This holds four special exhibits and one thematic display.

The control and monitoring of space flights is accomplished from points located in the territory of the USSR and also from ships of the space communication service, the scientific research ships of the USSR Academy of Sciences: "Kosmonavt Yuriy Gagarin," "Kosmonavt Vladimir Komarov" and "Akademik Sergey Korolev." A special exhibit entitled "Marine Fleet - Space Communication" tells of the history of development of shipboard measuring points and day-to-day work at these stations.

Still another exhibit tells about the new possibilities which scientists are afforded due to advances in rocket and space technology. The complexity and volume of the work done by means of space vehicles is constantly increasing. New sciences have appeared: comparative planetology, exoatmospheric astronomy, satellite biology and medicine. The "Space-Science" exhibit devotes its emphasis to the latest results of investigations carried out for study of the upper atmosphere and ionosphere of the earth and its magnetosphere, the sun, solar-terrestrial relationships, cosmic rays and planets of the solar system. Scientific instrumentation carried aboard space vehicles and intended for the implementation of scientific experiments is displayed.

The "Space Biology and Medicine" section familiarizes visitors with different aspects of biomedical research carried out on satellites, spaceships and orbital stations for more than 25 years now. During this time unique scientific material has been obtained. The stands tell of the results of experiments. The showcases hold special equipment for their implementation. Visitors can learn about the equipment and methods used in preventing unfavorable effects of spaceflight factors on man.

Life more and more insistently requires from cosmonautics not only a further advance, but also broader practical use of space technology in the national economy. The next exhibit, "Space Study of the Environment," tells of a relatively new direction in space research which arose about 10 years ago and which is now developing intensively. Automatic and manned space vehicles are outfitted with television, photographic and other apparatus used in study of natural resources and monitoring the environment. The photographs taken from space are already used rather extensively in geology, geography, oceanology and agriculture. They are also represented in the exhibit.

Any report on the "Space" pavilion would not be entirely complete without mentioning the thematic exhibit "USSR Astronomical Observatories." Here there are stands, models, instruments and books familiarizing the viewer with the most

important results of investigation of the planets of the solar system, moon, sun, stars, galaxies and comets. There is a map showing the distribution of astronomical observatories, radio telescopes and stations for observing artificial earth satellites. The modern optical-mechanical industry has outfitted Soviet observatories with first-class instruments of an original design with which visitors also can familiarize themselves.

A commemorative exhibit devoted to the 20th anniversary of man's first emergence into open space opened in March of this year and in April an exhibit commemorating the 25th anniversary of the Cosmonaut Training Center imeni Yu. A. Gagarin was opened. Opening in June will be the thematic exhibit "Space-Man" and the special exhibit "Youth and Space," related to the World Festival of Youth and Students.

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SPACE SCIENCES

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SOME POSSIBILITIES OF REPRESENTATION OF GRAVITATIONAL POTENTIAL BY SERIES ALWAYS CONVERGENT OUTSIDE ITS SURFACE

Moscow VESTNIK MOSKOVSKOGO UNIVERSITETA: FIZIKA, ASTRONOMIYA in Russian
Vol 26, No 5, Sep-Oct 85 (manuscript received 10 Oct 84) pp 77-81

CHUYKOVA, N.A., State Astronomical Institute imeni P.K. Shternberg

[Abstract] In processing surface and satellite gravimetric data the problem usually arises as to the possibility of using a single Laplace series for the representation of geopotential and its derivatives because the convergence of this series everywhere outside the planetary surface has been demonstrated only for a certain class of surfaces. For a surface of arbitrary form this problem can be solved by applying the Runge-Krarup theorem. An analysis of this problem indicates that planetary potential (and therefore, by virtue of the Weierstrass theorem of uniformly convergent series of analytic functions, the arbitrary derivative of potential) can be uniformly represented everywhere in the region of its analyticity in the form of the limit of sums of spherical functions in a form given in this article as the formulas (models) (5), (7). However, such a representation is not the only one possible. The coefficients on the spherical functions are quite dependent on the number of the approximation and on the region of observations. Since in the satellite region the Laplace series gives the best quadratic approximation for potential, in processing satellite data alone it is impossible to obtain the proposed universal models (5) or (7). A satellite model cannot be used for a surface not conforming to the conditions of convergence of a Laplace series on it. The proposed universal model (5), (7) can be obtained using either joint satellite and surface observations or surface data alone. The form and coefficients of the model will be highly dependent on to what smoothed terrestrial surface the surface observations are related. Among all representations of the type (5), (7) for each observation region there is a series of best approximation sums, determined by the choice of specific parameters. They can be found only from the processing of observations and they give the best approximation only in the observation region. Tables 2; references: 6 Russian.
[26-5303]

INTERPLANETARY SCIENCES

PHOBOS MISSION DISCUSSED AT INTERNATIONAL COMMITTEE MEETING

Kishinev SOVETSKAYA MOLDAVIYA in Russian 15 Nov 85 p 3

[Article by V. Ovcharov, correspondent]

[Text] The carrying out of a new international project, "Fobos," will become an important step in the study of planets of the solar system. This project calls for launching two Soviet automatic stations in 1988, for the purpose of studying the planet Marx and its satellites Phobos and Deimos. Preparations for this unique space experiment are being discussed at a meeting of the international scientific and technical committee for the "Vega" project, which is taking place in Moscow.

The attention of scientists from countries that are taking part in the project "Venera--Kometa Galleya" remains focused, as before, on the interplanetary stations "Vega-1" and "Vega-2," which have already traveled about a billion kilometers and will encounter Halley's Comet about 3 months from now. The spacecraft "Giotto" and "Planet A" of the European Space Agency and Japan are also rapidly approaching the comet. Principles formulated in the course of this extremely complex experiment are exemplary ones for cooperation among scientists of various countries in the peaceful exploration of space. Preparations for the "Fobos" project will be based on these principles.

The two "Fobos" automatic interplanetary stations are to be launched from the Baykonur Cosmodrome in July of 1988. The launches will be separated by an interval of several days. Each spacecraft will carry 30 instruments on board. It will take the stations about 7 months to make the trip to Mars. They will be approaching the planet early in 1989. Plans call for photographing the surfaces of Mars and its satellites and for studying the Martian atmosphere and the planet's magnetic field in the course of the experiment. The landing of small probes with instruments on Phobos is also proposed.

Specialists of Bulgaria, Hungary, the German Democratic Republic, Poland, Czechoslovakia, Austria, France, the Federal Republic of Germany, Sweden, and the European Space Agency are taking part in work on the "Fobos" project together with Soviet scientists.

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INTERPLANETARY SCIENCES

SAGDEYEV ON INTERNATIONAL TRACKING, PROCESSING OF 'VEGA' BALLOON PROBES

Moscow PRAVDA in Russian 27 Aug 85 p 3

[Article by Academician R. Sagdeyev, scientific head of project "Vega": "In the Clouds of Venus"]

[Text] Within the framework of the international project "Vega," which is opening an era of fundamentally new research on the atmosphere of Venus and also a program of studying the small bodies of the solar system--the comets and asteroids, the Soviet spacecraft "Vega-1" and "Vega-2" inserted two balloon probes into the atmosphere of Venus, in addition to their landers.

These autonomous scientific stations include a radio transmitting system, a unit of meteorological sensors, apparatus for transforming and storing data and a block of batteries. The weight of the balloon probe is 21 kilograms.

In the atmosphere of Venus the probes flew at an altitude of about 54 to 55 kilometers, where the pressure is 0.5 atmospheres and the temperature 40 degrees Celsius. This altitude corresponds to the densest part of Venus' cloud cover, in which, it was assumed, the action of mechanisms supporting the atmosphere's surprisingly fast rotation from east to west around the planet--the atmosphere's so-called super-rotation--is most apparent. In the upper part of the cloud layer the winds on Venus blow with hurricane speed--360 kilometers per hour and in 100 hours the atmosphere at this altitude manages a complete rotation along the planet's latitude.

The main task of the balloon experiment was to obtain new information about the dynamics of the atmosphere of Venus. A sonde, unlike a lander, makes it possible to conduct measurements over the course of an extended period of time and over various sectors of the planet. Each balloon probe was operating for 46 hours and in this time flew with the wind over 12,000 kilometers, measuring along its flightpath the temperature, pressure, vertical gusts of wind, the range of visibility in the clouds, the average amount of illumination and following the presence of light flashes. The balloon flights started from the middle of the planet's night region and finished their work on the daylight side.

The scientific value of the balloon experiment in Venus' atmosphere, which was determined by the contents and precision of the balloon's measurements

and the volume of data received on earth, was to a significant degree increased thanks to wide international cooperation in measuring the coordinates and speed of the sondes. The experiment utilized the method of long-base radiointerferometry, proposed earlier by Soviet radioastronomers. It works by a minimum of three radiotelescopes, located at great distances from one another, receiving signals simultaneously and recording these on magnetic tape together with marks of the exact time the signals were received. The coordinates and speed of the balloon probe are obtained as a result of joint processing of all the magnetic tapes.

The signals of the balloon probes were received by practically all the major radiotelescopes of the world. Thanks to this it was possible to record the telemetry data from the probes and measure their speed and position with maximum accuracy over the entire time of their operation. In the Soviet Union the signals were received on the enormous 70-meter antennas in Yevpatoria and Ussuriysk as well as the 64-meter dish outside Moscow and smaller dishes in Simeiz, Ulan-Ude and Pushchino.

In accordance with the proposal of the Intercosmos council, under whose program the balloon experiments of the "Vega" project were carried out, the French national center for space research (CNES) organized and coordinated an international network of radiotelescopes for the radiointerferometry measurement of the coordinates and speed of the balloon probes and reception of telemetry information from them. The scientific direction of the work of the international network was undertaken by well-known scientists, the French academician J. Blamont and the American radioastronomer R. Preston. The basis of this network was comprised of the three 64-meter U.S. dishes in Goldstone, Madrid and Canberra. Besides these, radiotelescopes in the cities of Eifelsberg (FRG), Onsaala (Sweden), Pentinkton (Canada), Arecibo (Puerto Rico), Greenbank (USA), Fort Davis (USA), Haystack (USA), Atibaya (Brazil) and Jodrell Bank (Great Britain) also operated. In addition, French scientists, in scientific cooperation with individual U.S. scientists, developed part of the scientific equipment of the probes.

The radiotelescopes simultaneously received and recorded in the same range the signals from the balloon probes and the reference signals from the "Vega" spacecraft. This permitted them to eliminate the distortions brought about by the interplanetary medium and earth's ionosphere, through which the signals propagated. The trajectories of the spacecraft "Vega-1" and "Vega-2" themselves were determined with high precision by measuring their angular distances relative to extragalactic sources of radio emissions--quasars. The margin of error in measuring the coordinates of the balloon probes comprised about 10 kilometers, the accuracy in measuring their speed--around 1 meter per second.

During the flight the express processing of the scientific information was accomplished practically in real time in Yevpatoria, Madrid and Goldstone. The communications channel between the Institute of Space Research of the USSR Academy of Sciences and the French space center in Toulouse, which received the information from the foreign radiotelescopes, functioned without fail.

The first evaluation of the telemetry information showed the presence of anomalously active processes in the cloud layer of Venus which were characterized by powerful rising and sinking flows. The flight path of the balloon probes passed through various different gas masses. Along the whole trajectory of its flight the drift of the first probe was warmer by 8 degrees. When the second probe was flying at a 5 kilometer altitude over the region of Aphrodite it passed into a peculiar kind of air pocket, which sank sharply approximately 1.5 kilometers. Both probes "noticed" on the night side of the planet a change in the background level of illumination, something which could be linked with infrared radiation from the surface of the planet or with atmospheric processes.

The complete telemetry data will soon be available to scientists for further processing and analysis. The processing of the results of measuring the coordinates and the speed of the probes is planned to be completed at the end of 1986. But it is already possible to say that the enormous task of developing the means for qualitatively new investigations of Venus' atmosphere has been accomplished by the obtaining of unique data, which were not available earlier.

The balloons were created by a collective led by Corresponding Member of the USSR Academy of Sciences V. Kovtunenko and by R. Kremnev. The devices of the probes' payloads were subject to significantly stricter limitations as to weight, dimensions, energy use and reliability than for the devices on the basic spacecraft. New arrays of receiving and recording devices on all Soviet radiotelescopes made possible reliable reception of telemetry information with an unusually small signal strength from the probes and highly accurate radiointerferometry measurements, in addition to software necessary to separate the very weak signals from the noise, provided for the success of this highly complex experiment.

Never before has such an experiment been carried out under such stringent limitations for onboard devices and such an extremely low level of signals to noise on earth. This was the opinion expressed by both Soviet and foreign participants in the experiment. All possible reserves of mass and power were expended to increase the volume of the scientific data receivable: new sensors were installed, the speed of data transmission was raised as was the length of operation. And all the participants in the experiment are glad that the risk was not in vain. This original program shows how great the creative potential of science is in the interests of the peaceful study of space.

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INTERPLANETARY SCIENCES

RESULTS FROM VENUS CLOUD STUDIES ON 'VEGA' CRAFT

Moscow PRAVDA in Russian 18 Nov 85 p 8

[Article by V. Moroz, professor, head of a department of the USSR Academy of Sciences' Institute of Space Research, and L. Mukhin, doctor of physical-mathematical sciences, head of a laboratory]

[Abstract] The authors report on results of studies that were made of the clouds of Venus with the aid of the probes that were released by the automatic interplanetary stations "Vega-1" and "Vega-2." Each of the capsules that descended through Venus' atmosphere carried several instruments for measuring the chemical composition of cloud particles, the size of particles and their distribution by altitude.

Direct measurements of the content of sulfuric acid in cloud particles were made with the "Sigma-3" instrument on both capsules. It is mentioned that this instrument was developed by the All-Union Scientific Research and Design Institute of Chromatography of the USSR Ministry of Instrument Building, and by the Institute of Space Research. Results showed that in clouds at altitudes from 63 to 48 kilometers, there is on the average, about 1 milligram of sulfuric acid per cubic meter of atmosphere. Separate measurements reportedly were made with the aid of a mass-spectrometer with an aerosol collector. This was a joint experiment of the USSR Academy of Sciences' Institute of Geochemistry and Analytical Chemistry, and of France's Center for Environmental Protection. Results of this experiment are said to concur with the data from the "Sigma-3" instrument.

The authors report that another experiment established that clouds of Venus also contain sulfur, chlorine, and apparently phosphorus, which was detected for the first time. The results also indicated to researchers that part of the sulfur is in free form, forming particles that give the clouds a yellow hue. An absorption band that is characteristic for free gaseous sulfur was observed with the aid of an ultraviolet spectrometer, which was part of another Soviet-French experiment. Detailed data on the concentration of particles of various sizes in relation to altitude were obtained with the aid of a special instrument which counted separate particles that passed through its field of vision. This was a photoelectric aerosol spectrometer. Another instrument measured light-scattering properties of the clouds, and also natural radiation in the atmosphere.

The authors relate that analysis of the data indicates that small particles that are tenths of a micrometer in size are predominant in Venus' clouds. If one counts all particles that are larger than 0.4 micrometer in diameter, their number in a cubic centimeter would not exceed several hundred. The authors observe that although the results of both aerosol "counting" experiments are in agreement, the results are sharply at odds with those that were obtained in a similar experiment that was conducted in 1978 by the U.S. Pioneer-Venus probe, which detected a considerably larger number of large particles.

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INTERPLANETARY SCIENCES

COMMENTARY ON 15TH LUNAR-PLANETARY CONFERENCE

Moscow ZEMLYA I VSELENNAYA in Russian, No 6, Nov-Dec 84, pp 43-45

[Article by V. V. Shevchenko, doctor of physico-mathematical sciences, under the rubric "Symposiums, Conferences and Congresses": "Lunar-Planetary Research"]

[Text] Every year in Houston there is a lunar-planetary conference, at which the current results of the work of scientists studying the solar system's bodies are summed up. The conference is organized by the U.S. Lunar-Planetary Institute of the University Association for Space Research and by NASA's Johnson Space Center. Originally the conferences were concerned only with lunar research. Later, as of March, 1978, the meetings' scientific program was expanded and began to include many other questions connected with the study of the solar system.

Nearly 500 planetologists and scientists with allied specialties participated in the work of the 15th Lunar-Planetary Conference, which took place in March, 1984. In all, at 28 sectional meetings, almost 300 oral reports were heard and they touched on such themes as: the study of regoliths; the origin of the crust; lunar petrology; lunar geology; planetary physics; the study of isotopes; the study of meteorites; the study of shock crater formation; the satellites of the giant planets; Mars; Venus; the evolution of the solar system; asteroids and comets; and cosmic dust.

In the conference's reports and printed materials, as well as at the numerous booths and displays, a large number of scientific results were imparted. Special interest was aroused by the discussions on several problems which we will talk about in more detail.

In recent times, among specialists involved in planetary chemistry, the opinion has been disseminated that several meteorite fragments found in various regions of the terrestrial sphere may be fragments of rocks of Martian origin (ZEMLYA I VSELENNAYA 1984, No 2, p 35--Ed.). These specimens differ somewhat from the majority of meteorites which arise as the result of a breakdown in the original compositional material of asteroids. There are now eight similar fragments. Two of them were found in Antarctica. The larger of these fragments was recently subjected to a detailed analysis. The specific features distinguishing the examined fragments from the known types of meteorites lead to the following conclusions. The specimens found in Antarctica have a high percentage of water

and several other volatile elements, as well as an isotopic-abundance ratio of oxygen and of potassium to uranium. Attention is drawn to the relatively young age of the crystallization of the specimen found in Antarctica, which is 1.3 billion years old. This indicates that on the celestial body which produced the meteorite fusion processes were still occuring in the recent geological past. Consequently, it can be assumed that the fragment belonged to a large and dynamically active planet. The meteorite was examined for its content of such gases as argon, krypton, xenon and nitrogen. Thanks to the rubidium-strontium isotopic method of dating it was established that the fragment under study had been subjected to an impact action approximately 180 million years ago, as a result of which glassy occlusions were formed during the partial fusion of its material. The above named gases were discovered in them and their percentages differ greatly from similar gaseous components of other meteorites. At the same time, the measured ratios agree closely with data obtained by the Viking spacecraft about the composition of the Martian atmosphere. The relative percentages of the isotopes argon-40, argon-36, xenon-129 and xenon-132 are analogous with the parameters of the Martian atmosphere and do not agree with the characteristics of other objects of the solar system. The discovered high percentage of the isotope nitrogen-15 in relation to nitrogen-14 has been noted so far only in the Martian atmosphere.

A more convincing explanation of these peculiarities, as it is supposed, may be the hypothesis about the entrapment of the indicated gaseous components by the molten surface of the fragment 180 million years ago when it suffered an impact. The close correlation between the percentages of the gases and the known parameters of the Martian atmosphere compels one to draw the conclusion that the gaseous blanket of Mars was their source. It is possible that the fragment under investigation had been thrown from the surface as the result of an explosion during the descent of a large meteorite or asteroid. Its long journey through interplanetary space ended on the surface of the terrestrial sphere, in Antarctica.

RESEARCH ABOUT VENUS is continuing at an intensive pace. Using the radar system of the Arecibo Radioastronomical Observatory on a wavelength of 12.6 cm, radar images have been obtained of the Beta region of Venus (ZEMLYA I VSELENNAYA 1984, No 1, p 2--Ed.). In the course of this experiment a high degree of resolution of nearly 2 km of the planet's surface was achieved. According to the results of much earlier research with less resolution the Beta region was already believed to be a structure of volcanic origin similar to the Tharsis Mountains on Mars. Now this conclusion is being confirmed by the disclosure of such details as rift systems, lava flows and formations analogous to terrestrial calderas. Investigations of the Beta region permitted the assumption that vulcanism is a global process, which is molding the surface contour of Venus.

Sonar pictures of the bottom of the Pacific Ocean in the region of the Marianas Islands revealed structures which have a definite resemblance to surface formations on Venus. In connection with this proposals were put forward that it might be possible to draw an analogy between the processes which have formed the contour on Venus and on our planet in a specific geological epoch.

Global research on the Venusian surface using radar from Earth and from orbiting

satellites has enabled the statistical isolation of regions possessing typical morphological features. Radar reveals such characteristic contours as planes according to altimetry data, the pitting of the surface according to the mean square values of the slope angles of small sections of the surface, as well as reflectivity in the longwave radio frequency range. The flatlands of Venus appear to be extremely pitted, but on the average they are smoother than the lunar seas, for example. At the same time, it was discovered that the pitting of the surface layer grows as the altitude plane of the landscape increases.

The reflectivity of material in the radio frequency range depends on the electrical properties and porosity of the material in the surface layer no deeper than 1 meter. Rocks with a relatively high percentage of iron and titanium have a high degree of reflectivity. Silicates characteristically have a lower degree of reflectivity. Proceeding from the average value for the Venusian surface's reflectivity in the radio frequency range it is possible to assume that the larger distribution is made up of rocks with low porosity and dielectric properties, which are typical features for terrestrial silicate rocks. In particular, this means that the largest part of the planet's surface is not covered by a layer of regoliths from shattered material of impact origin. A similar model is supported by the data from the panoramic pictures of the surrounding landscape and from the results of the determination of the chemical composition of rocks obtained by the Soviet Venera series automatic stations. As a rule the reflectivity decreases as the altitude level of the flatlands type landscape increases.

A highly porous material, which may turn out to be friable soils, is concentrated basically in the elevated flatlands and low, mountainous regions. Typical flatlands--the most widespread type of Venusian landscape--may possibly be covered with regoliths to an insignificant degree. The landing site of the Venera-14 automatic station may serve as an example. There the surface layer is practically devoid of thinly dispersed friable material. The reverse is true for the landing sites for Venera-10 and Venera-13, where the presence of friable soils was noted in significant amounts. The overall analysis of the Venusian surface features, determined at present by radar, permitted the distinguishing of 11 types of landscapes. "Rolling flatlands" occupy 43 percent of the planet's surface, typical flatlands--26 percent, lowlands of the flatlands type--10 percent, transitional regions between flatlands and mountains--14 percent, typical mountains--4 percent and the remaining 1-2 percent of the entire surface area is made up of other contour forms.

The conference's participants listened with very great interest to the reports of the Soviet scientists, V. L. Barsukov and A. T. Bazilevskiy, on the latest results of radar pictures of the Venusian surface from on board the Venera-15 and Venera-16 automatic stations, which, orbiting the planet as satellites, began transmitting their first scientific information to Earth by the beginning of the conference (ZEMLYA I VSELENNAYA 1984, No 1, p 2--Ed.).

The conference materials contained reflections and questions on the future planning of experiments connected with the investigation of the SOLAR SYSTEM by spacecraft. Thus, the Special Committee for the Study of the Solar System, composed of leading American planetologists, is recommending the carrying out

of a number of projects for the period up to the end of the current century. The overall program defines four main directions for research: the study of questions on the origin, evolution and present make-up of the solar system; a comparative study of the planets and large satellites of the solar system in order to understand the global processes of the Earth's nature; a study of the chemical and physical evolution of the solar system's bodies in order to understand the process of the origin of life; and the search for and study of natural resources in near-Earth space, including the Moon and those asteroids which periodically approach our planet.

In order to realize the outlined program, besides the launch of a probe towards Jupiter, planned for 1986, it is being proposed that a satellite be placed in orbit around Venus to complete the radar picture of the surface in 1988, that a satellite be placed around Mars to study the planet's surface and atmosphere in order to clarify the processes which influence the formation of climate, that a probe be sent to a comet or asteroid in 1990-1992 and that a probe be sent to investigate Titan in 1988-1992.

Several similar projects, such as the radar pictures of the Venusian surface or the flight of a spacecraft towards a comet, are also being carried out in our country. In connection with this many American collegues expressed the opinion that scientific exchange and cooperation between our countries in this area would be greatly beneficial for both nations.

Apart from the balanced program providing for various directions, each of which will require relatively modest material expenditures, the idea, so to speak, of a key project is being put forth. In order to achieve it scientific and technological forces need to be concentrated on a national scale. It is being proposed that such a project be the establishment of a permanently active, inhabited base on the lunar surface at the beginning of the next century.

The conference organizers created favorable conditions for members of the Soviet delegation to establish fruitful and mutually beneficial scientific contacts with American collegues.

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LIFE SCIENCES

SHKLOVSKIY DISCUSSES POSSIBILITY OF EXTRATERRESTRIAL INTELLIGENCE

Moscow ZEMLYA I VSELENNAYA in Russian No 3, May-Jun 85 pp 76-80

[Article by I. S. Shklovskiy, corresponding member, USSR Academy of Sciences (deceased)]

[Text] The "silence" of the universe can be completely and naturally attributed to the fact that extraterrestrial civilizations have either perished, not being able to contend with the problems that arose in the course of their own development, or there have never been such civilizations. In an examination of the history of terrestrial civilization we see that there are global problems in the present era and an inability to solve them can lead mankind to destruction. The proposed hypothesis makes possible a more profound discussion of the broad range of problems related to the future of mankind and the extent to which life occurs in the universe.

The basis for the article is a report which the author presented at the 27th International Geological Congress (Moscow, 1984). Iosif Samuilovich signed this article to press shortly before his untimely death, which occurred on 3 March 1985.

There is no need to demonstrate the long-known fact that science cannot obtain a sufficiently complete idea concerning a studied object if it is known in only one, single example. The study of nature always begins with a classification, a systematization. I will cite two examples.

At the present time, despite the enormous successes of science in investigation of the planets (primarily by the direct methods of cosmonautics) and the sun, the problem of the origin of our solar system is still extremely far from being solved. On the other hand, the origin and evolution of the stars, incomparably more remote and therefore inaccessible for investigation by direct methods, have become quite well known. In this field of knowledge the successes are simply amazing. What is the reason for such a paradoxical situation? It is evident: a planetary system is known in a single example, whereas astronomers by means of powerful instruments have long observed a gigantic

number of stars which are in different stages of evolution*.

The problem of the origin of life on the earth is completely unclear and very confused. It has come to this that one of the leading biologists of our times, F. Crick, relatively recently tried to resurrect a variant of the ancient hypothesis of "panspermia" (the roots of which go back to the teachings of the fathers of the church about the "germs of life"). The unacceptability of the panspermia hypothesis is evident if for no other reason than that life is a historical category, and by no means eternal, as assumed by S. Arrhenius. It could not exist in the early stages of evolution of the universe, when neither stars nor galaxies, nor even heavy elements existed. Therefore, one cannot get away from the question: how did living matter arise from unliving matter? It is absurd to seek some other cosmic objects with completely unclear physical properties in place of the primordial earth. Such a pitiful state of this problem can be attributed to the simple fact that we do not know of other forms of life in the universe (other than terrestrial). Accordingly, the important question arises of the occurrence of life in the universe. However, one should not fall into a mood of deep pessimism. We astronomers lay great hopes on an orbital optical telescope with a mirror diameter of 2.4 m which will come into operation in a year. There is basis for assuming that using this instrument it will be possible to discover the planetary systems closest to the sun. With respect to extraterrestrial life, there is hope for detecting it on the basis of those transformations through which it goes in the atmospheres of the parent planets (we recall the origin of oxygen in the earth's atmosphere).

But for the time being we can only formulate more or less sound hypotheses concerning life in the universe and the possible ways in which it developed. In this process we must rely on the enormous volume of facts which we already know about the universe, and of course, on biophysics, biochemistry, genetics and evolutionary biology. Since the material carriers of life are complex and ultracomplex molecules in whose structure a decisive role is played by the heavy elements**, the appearance of life in the universe must be assigned to the epoch when the chemical composition of a considerable number of stars (but, it goes without saying, not all) was already close to that of the present time. A rough estimate gives a value of the red shift for this epoch $z_1 \sim 4\text{-}5$, from which it follows that the age of the universe at that time was $T = T_0 (1 + z_1)^{-3/2} \sim 10^9$ years, where $T_0 \sim 16$ billion years is the most probable value of the age of the universe. It can be assumed that since those times favorable conditions for the appearance of life appeared in different galaxies. In our solar system, on one of its planets, on the earth, such

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* Recent observations made with the IRAS satellite, outfitted with infrared telescopes, resulted in the discovery of dust disks near Vega and some other near stars, possibly being an early phase in formation of planetary systems. Thus, some progress has finally been made toward solution of this highly important problem.

** Elements whose atoms are heavier than helium.

conditions appeared rather soon after its formation 4.6 billion years ago*. It must not be forgotten here that the very process of formation of the solar system extended to a good hundred million years. Since the process of the formation of stars and planetary systems transpires continuously in the universe, it can be asserted that an individual center of life in it can have an age (and accordingly, time for its evolution) from approximately 15 billion years to several hundreds of millions of years. Accordingly, our terrestrial life is among the most ancient.

However, at the present time we can say absolutely nothing concerning the probability of the origin of life on any young planet. The example of our solar system, in which there is only one inhabited planet, the earth, demonstrates that life by no means develops on every planet. Now it is impossible to preclude the assertion that the fraction of inhabited planets may be negligibly small. And for the time being we are not discovering beyond the limits of the solar system any planets whose atmospheres have been transformed by life and until they are there evidently will be no significant progress in solution of this fascinating problem.

It would seem that this problem can be approached from the biochemical point of view by experimentally synthesizing very simple living matter "in a test tube." However, such an experiment can scarcely solve the problem of the mechanism of appearance of life on the primordial earth because presently we visualize the physical and chemical conditions prevailing on it too poorly, in an extremely generalized way. The specific nature of the problem of life in the universe is that this problem can be formulated very clearly and distinctly, but in the foreseeable future cannot be solved by scientific, that is, primarily experimental and observational methods. In this respect it is considerably more difficult than such acute problems in modern physics as, for example, the problem of the finite rest mass of a neutrino, the spontaneous decay of protons, the great unification of interactions, and even the problem of other universes.

Particularly relevant is the problem of intelligent life beyond the earth's limits. It is superfluous to emphasize that since ancient times it has excited mankind most of all, in any case more than the problem of "simple," unreasoning life in the universe. What can be said along these lines? To be sure, if individual centers of life can exist in the universe, why could there not be centers of reasoning life? The evolution of life from the most simple forms to the most complex forms is a very prolonged and extremely complex process. The main moving forces of this process are Darwinian natural selection and mutation. It can be assumed that this is correct not only for terrestrial, but also for extraterrestrial life, because the resources for nutrition and the support of vital functions of organisms, wherever they might develop, are always limited. In the course of evolution, by reason of severe necessity, other, highly important, frequently very complex "inventions" appeared ensuring the survival of types of living beings. Among such "inventions" we should include,

* Investigations of the $^{12}C/^{13}C$ ratio made recently by the German geochemist Schidlovsky using ancient rocks graphically demonstrated that life on earth appeared at least 3.8 billion years ago, that is, no later than 0.8 billion years after its formation.

for example, photosynthesis, "camera vision," and a lot else. We can regard reasoning as one of these "inventions." Like other "inventions" arising in the course of the evolutionary process, it gives to the corresponding species first small, and then ever-increasing advantages in the struggle for existence.

A distinguishing characteristic of reasoning is the unusually short time scale of its development. For the Homo Sapiens species this scale in the beginning could be reckoned as hundreds and tens of thousands of years. However, with the onset of the technological era the rate of development accelerated catastrophically. A species which has acquired reasoning loses equilibrium with the biosphere and enters into a phase of explosive expansion. In this development phase reasoning ceases to be one of the means ensuring survival of the species. It becomes a powerful independent factor. This can be seen clearly in the example of evolution of mankind. Indeed, in order to ensure existence of the species Homo sapiens it would be entirely adequate to have a Neanderthal brain. Things begin to get "tight" on the parent planet for a reasoning species. Expansion into space with its subsequent transformation begins. This expansion process can be likened to a shock wave. Greater and greater resources of matter and energy are drawn into the sphere of activity of the reasoning being. Entirely reliable, scientifically sound evaluations show that in principle some thousand years are adequate for mastery of the material and power resources of the parent planetary system. For example, whereas the present-day rate of transformation of energy is approximately 10^{20} erg/s, after a thousand years it can attain about 10^{30} erg/s when mankind has populated the entire solar system, which reasoning beings are capable of transforming into an artificial biosphere with resources billions of times greater than the natural, "parental" resources. At the same time, artificial reason, which in essence can no longer be separated from the carriers of "natural" reason, attains the very highest levels. This path of development was mentioned many years ago by K. E. Tsiolkovskiy, and recently, by F. Dyson.

But this progress (if it can be called progress) is not thereby limited. Surely the "shock" wave of reason begins to be propagated to the entire Galaxy, as was pointed out for the first time by N. S. Kardashev. For the mastery of the resources of a star system and its total transformation, according to the most conservative estimates, a time of only a few million years is required. This time is entirely insignificant in comparison with the 10-15-billion-year history of evolution of the Galaxy or even the 200-million-year period of its rotation!

It may appear that we are discussing not a scientific problem, but some fantastic cosmology which recently has been quite fashionable. We are talking about a real analysis of the prospects for the development of mankind over a quite long time. It therefore follows that the problem of extraterrestrial civilizations is not only an astronomical, technical and biological problem, but also a sociological problem, to be more correct, a "futurological" problem. We are dealing with a highly complex, multisided problem.

To be sure, it can be assumed that reasoning beings, comprehending the destructiveness of unlimited expansion, undertook a rigorous self-restriction of the quantitative growth of the principal indices of their civilizations. However,

it is scarcely possible to assume such a strategy of development to be the same for all civilizations. This is simply not realistic. Moreover, development "only in depth" is most likely an illusion.

The inevitable conclusion can be drawn that at least a small percentage of the civilizations developing in the universe should be in the stage of unlimited expansion. But in such a case we would observe cosmic manifestations of reasoning life, that is, some sort of "cosmic wonders." And now we come to the main point: despite the incredibly increasing effectiveness of our telescopes and radiation detectors in the entire range of electromagnetic waves, it has not been possible to detect any "space wonders." And indeed, modern astronomy has begun to use all wavelengths! No "Dyson spheres" have been seen in the sky, the "call letters" of our "brothers in reason" have not been heard, no traces of cosmic construction activity have been observed, no one has ever visited our old earth (and it would seem that they should have, since it is an attractive and comfortable planet!) And there is an enormous desire on the part of earthlings to communicate with their mentioned brothers, a reflection of which is the mass preoccupation with UFOs (unidentified flying objects). The universe is silent, not revealing even any evidence of reasoning life. But there could be! For example, supercivilizations should have powerful radio beacons. It can be asserted, however, that in the neighboring galaxy M 31, in which there are several hundred billion stars, there is nothing of the sort.

The "silence" of space is a highly important scientific fact. It requires explanation because it is in obvious contradiction with the concept of great supercivilizations developing without limit. Thus, the problem of "extraterrestrial civilizations would seem to be "refuted." It would seem that we are dealing with the problem of "looking for a needle in a haystack." In actuality, this seems to be a matter of looking for something that is not there. The simplest, one might say, trivial explanation for the phenomenon of a "silent universe" is: ultrahighly developed extraterrestrial civilizations simply do not exist in the immediate neighborhood of the great universe (for example, in the local system of galaxies). Even with the widespread occurrence of the phenomenon of life in the universe this is entirely possible. It is only necessary to make the natural assumption that in the process of evolution of life the sought-for civilizations either did not develop at all, or by virtue of internal factors in their development (such as the inevitable destruction of their biospheres giving rise to them) have a very short lifetime.

If we adhere to the entirely natural point of view that reason is one of the "inventions" of the evolutionary process, it must not be forgotten that not all "inventions" in the long run are useful for a given species. Nature is blind, it acts by "feel," by the "trial and error" method. And it appears that an enormous percentage of these "inventions" are unnecessary and even harmful for the fluorishing of the species. "Dead-end" branches thus appear on the trunk of the tree of evolution. The number of branches is incredibly great. In essence, the history of evolution of life on earth is a graveyard of species*. A distinguishing characteristic of an evolutionary blind alley for some

* According to evaluations of evolutionary biologists, about 10^9 species have evolved since the beginning of life on the earth. At the present time there are approximately $2 \cdot 10^6$.

species is the hypertrophy of some function, leading to a progressively increasing disruption of harmony. We recall the monstrously hypertrophized means of protection and offense (horns, armor, etc.) of Mesozoic reptiles. Or, for example, the improbably well-developed canine teeth of the saber-toothed tiger. An analogy involuntarily suggests itself: are not the present-day contradictory "uses" of reason by the species Homo Sapiens, hypertrophized to the highest degree, an indication of an approaching blind alley for this species? In other words, is not the suicidal activity of mankind (monstrous accumulation of nuclear weapons, annihilation of the environment) the same as a hypertrophy of its development, like the horns and armor of some triceratops or the canine teeth of the saber-toothed tiger? Finally, is not the blind alley an end to the evolution of reasoning beings in the universe, which would naturally explain its silence?

Holding to the point of view that reason is only one of numerous "inventions" of the evolutionary process, and also that it is not impossible that it leads the species endowed with it into an evolutionary blind alley, we will first of all comprehend better the place of man in the universe, and second, we will explain why cosmic "wonders" are not observed. And this is really quite a lot...

The idea that reason is a manifestation of some nonmaterial, transcendental principle appears as an alternative to the already outlined, by no means "optimistic" concept. This is the old idea of god and a divine nature of human reason. This concept somehow seems more optimistic and even moral to individuals far (and not always far) from science. However, in our day it is difficult to take a position which has so little in common with science. Forgetting of the fundamental fact that we are part of an objectively existing, knowable material world, would not be good for anyone, even should it create a spuriously optimistic illusion.

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LIFE SCIENCES

'SALYUT-7' ELECTROPHORESIS EXPERIMENTS AID MEDICAL RESEARCH

Leningrad LENINGRADSKAYA PRAVDA in Russian 13 Oct 85 p 2

[Article by T. Chesanova]

[Abstract] The article reports on work which the Leningrad Scientific Research Institute of Vaccines and Serums is doing on obtaining extra-pure biological preparations for medical research, using space technology.

Candidate of Biological Sciences Albert Ivanovich Krashenyuk, head of the institute's laboratory of live influenza vaccine, is quoted in regard to space experiments which personnel of the institute have been conducting in collaboration with the Crimean Medical Institute, the Moscow Higher Technical School imeni Bauman, and other institutions. Experiments performed by crews of "Salyut" orbiting stations have been aimed, in particular, at obtaining extra-pure hemagglutinin and other surface proteins of the influenza virus, using the method of electrophoresis. The series of space experiments called "Tavriya" demonstrated that such products can be obtained comparatively quickly and easily in conditions of zero gravity, Krashenyuk related. Commenting on progress in automating the space experiments, he mentioned that a new-generation electrophoretic unit called "EFU-Robot" is now in use on the "Salyut-7" station. This unit was developed by the Institute of Bioorganic Chemistry. The "EFU-Robot" can be programmed by a cosmonaut to select samples of substances purified in the course of experiments and automatically transfer the samples from the unit's working chamber to ampoules, using syringes. Preparations obtained during the current manned orbital mission were delivered to earth recently by cosmonauts V. Dzhanibekov and G. Grechko.

With regard to the prospective application of these research results, Krashenyuk mentioned plans for producing immune serums on the basis of extra-pure proteins obtained in space. On the basis of one such serum, Krashenyuk and his colleagues hope to obtain a fundamentally new preparation for diagnosing influenza with high accuracy. These proteins and serums will also serve as standards for monitoring the purity of products of the vaccine institute. It will become possible to evaluate vaccines' hemagglutinin content by weight, for example. Mention is made in this connection of a completely automated line for the production of influenza vaccine which is now in operation at the institute. Specialists of the USSR Acacemy of Sciences' scientific and technical department developed this line, which is said to have no counterparts in the world.

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SPACE ENGINEERING

USSR-GDR CONFERENCE ON SPACE INSTRUMENTATION

Frunze SOVETSKAYA KIRGIZIYA in Russian 16 Oct 85 p 3

[Excerpt] A considerable number of international space programs in the interests of science and the economy have been carried out within the framework of the "Intercosmos" program. Bilateral "space" ties also are developing productively, particularly between the USSR and the German Democratic Republic.

A conference of heads of projects for development of space scientific instrumentation between these two countries is now being held in Frunze. The participants in this conference are discussing the progress of joint work, as well as plans of cooperation for development of new optical-electronic instruments for research of outer space for peaceful purposes.

The Soviet delegation at the conference is headed by G.M. Tamkovich, deputy director of the USSR Academy of Sciences' Institute of Space Research and a USSR State Prize laureate; the GDR delegation is headed by Comrade Bernd Reinhold, a director of the national enterprise "Karl Zeiss Jena." Eminent specialists in the field of space research and designers and engineers are among the members of the delegations. Representatives of the space research institute's Frunze Special Design Bureau (OKB IKI) are also taking part in the conference's work.

Specialists of OKB IKI have collaborated in the past with "Karl Zeiss Jena" enterprise, which produces optical instruments. An instrument called "Fragment-2" was developed jointly with colleagues of the GDR. This multichannel scanning system for study of the earth's natural resources from space has performed excellently in peaceful space orbits.

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SPACE ENGINEERING

COOPERATION OF FRUNZE INSTRUMENT DESIGN BUREAU WITH FRANCE AND WEST GERMANY

Frunze SOVETSKAYA KIRGIZIYA in Russian 16 Oct 85 p 3

[Article by A. Barshay, correspondent]

[Abstract] The article reviews results of cooperation between the Frunze Special Design Bureau of the USSR Academy of Sciences' Institute of Space Research (IKI) and space organizations of France and West Germany.

Sultanbek Tabaldyyev, deputy chief designer of the Frunze design bureau, related that its work with French scientists and engineers goes back about 10 years. This collaboration began with the development of a gamma telescope, the "Gamma-1." Later an instrument called "Altair" was developed at the bureau for a Soviet-French experiment, "Arkad-3," which was conducted with the Soviet satellite "Orel-3" in the fall of 1981. The "Altair" was used to study luminescence of the earth's atmosphere and to orient instruments in relation to the stars.

Particular attention is devoted to the bureau's role in the development of instruments for probes of the planet Venus and Halley's Comet carried on the "Vega" interplanetary stations. The Frunze bureau developed an ultraviolet spectrometer for analyzing the gas composition of Venus' atmosphere from lander modules which were released from these stations. Professor V. Moroz and Candidate of Sciences A. Ekonomov, associates of IKI, were the scientific directors for development of this on the Soviet side. Aleksandr Rabnikov, an engineer of the design bureau and senior project designer of the spectrometer, related that it consisted of a gas-intake device; a source of ultraviolet radiation; a spectral unit which converts UV radiation into the optical spectrum and records it; and information-processing and power-supply units. French specialists developed a circuit for the spectral portion of the instrument and built the information-processing unit and certain optical-electronic components for it. In addition to designing the spectrometer as a whole, personnel of the bureau developed and built a control and measurement complex for checking the operational fitness of all of its systems, particularly the French-made unit, and they did the ground testing and calibrating of the instrument.

Tabaldyyev also commented on the dust-impact mass analyzer PUMA which is installed on the "Vega" stations. Specialists of France and the Federal

Republic of Germany worked with the Frunze bureau on its development. The PUMA will be used to study the element composition, size and concentration of dust particles in the tail of Halley's Comet. Tabaldyyev noted that the analyzer incorporates the latest achievements of optics, thermal physics, microelectronics, computer technology, and mechanics. It is said to be capable of registering dust particles with masses of a millionth of a milligram and of determining their element composition with a precision as high as one-tenth of 1 percent.

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SPACE APPLICATIONS

USSR DEPUTY MINISTER OF GEOLOGY INTERVIEWED ON SPACE APPLICATIONS

Moscow ARGUMENTY I FAKTY in Russian No 27, 2 Jul 85 pp 4-5

[Interview with V.M. Volkov, deputy minister of geology, by N. Popadin; date and place not specified]

[Text] Cosmonautics has enriched our knowledge not only of space, but of earth and of ourselves as well, and has helped solve many national economic problems. It is now hard to name a sector of the national economy which has not benefited from the conquest of outer space.

Our correspondent N. Popadin discusses how the results of space research are being used in geology with Deputy Minister of Geology V.M. Volkov.

[Question] Vladimir Mikhaylovich, please tell us what sort of geologic research is being conducted from space today.

[Answer] The results of space research, naturally, are being used not only by geologists. The press repeatedly reports that this research is making it possible to track the status of crops and predict harvests, solve problems of soil reclamation, including those related to redistributing the flow of northern rivers, to study the country's forest reserves, to improve geographical maps. But I will dwell only on tasks close to me--in the study of mineral resources.

The basic trend is in photographing the earth's surface. This is being done from unmanned satellites in the "Meteor" and "Cosmos" series and by the "Salyut" manned orbiting station. Space photographs are an important source of new geologic information. With them we can identify features of geologic structure which specialists could not account for previously. The quality of these photos is very high. Besides black-and-white and color, we are receiving multizonal images from which, using instruments, we can recreate a color picture of the earth in natural or false colors, where geologic targets of special interests to us can be shown in relief. Cosmonauts take these pictures using stationary and portable cameras and the "Niva" Videotape System. It is probably time to consider the need for a specially trained geologist to work in orbit.

The abundance, the basic novelty, and the unfamiliar and often prolematic nature of the information revealed by space photographs has motivated us to begin compiling special maps and to conduct comprehensive work in individual areas. There is a great deal of interest in surveying concealed fractures--giant cracks in the earth's crust, along which deposits of many minerals are often concentrated. Research in these areas is directly related to the geologic service's basic task--to expand the country's mineral-raw material base.

The flow chart for the country's geologic research includes independent types of work based on preferential use of space data.

Our ministry has a system for receiving, processing, and distributing space information, which encompasses a large number of specialized subdivisions. It includes the lead organization, the "Aerogeologiya" Geologic Production Association, more than 50 space-aerogeologic groups in associations dispersed across the entire country, and more than 10 groups in industry scientific research institutes.

New trends constantly arise in space geology. These trends result from the development of current economic tasks which can be accomplished using space data.

Recently a great deal of attention has been given to monitoring the effect geologic workings have on the environment. This work is being done in several large mining regions.

The possibility of observing various geologic objects directly from orbit is attracting specialists. Experiments conducted by cosmonauts on the "Salyut" orbiting station have shown the value of such experiments.

[Question] How important to our economy are the results of earth sensing from space?

[Answer] Hundreds of prospective deposits of various minerals are being discovered every year as a result only of space research. Detailed exploration is going on in many of them. Some of the types of raw material which can be developed relatively quickly are already being used by industry. Among these--and this is something we want to stress--are deposits of several building materials which are so necessary to the national economy.

Of course, discovering new deposits requires use of our entire arsenal of mineral exploration methods and equipment. However, in the early stages of geologic exploration, when scientific prediction is being done, analysis of space photos often makes it possible to identify previously unknown mechanisms in the arrangement of ore beds. Thus, there are new recommendations, new predictions, and, ultimately, new geological concepts.

Use of space photos has already helped identify new ore regions and ore sites, including those in northern Siberia, the Far East, and Yakutiya. Photos from space have revealed many dozens of so-called prospective "photoanomalies,"

i.e., deep strata with characteristics favorable for formation of oil and gas beds have been detected.

We know that the cost of space photos of the earth's surface is 10-15 times less than aerial photography, and this can be confirmed by practice in the designing, building, and developing of territorial production complexes in eastern Siberia (the BAM zone), Kazakhstan, and Central Asia.

[Question] Are the resources invested in geological research from space recovered?

[Answer] Launching artificial orbiting stations is an expensive undertaking. But exploring for minerals is also not cheap. One might also say that the costs of launching a satellite and of drilling a deep well somewhere are commensurate. Not long ago, special studies were done to evaluate the cost-effectiveness of using space data in geologic exploration. For example, it helps identify territories for immediate detailed work. It was calculated that, in this case, the annual savings can be estimated at roughly 30 million rubles.

But, more important to the national economy, these studies help identify new fields much more quickly than before. Of course, precise figures can be determined only when geologic exploration is completed--in 10 years, perhaps. But even by the most conservative calculations, the national economy enjoys a benefit amounting to hundreds of millions of rubles.

[Question] We know that the USA and other countries are conducting earth research from space. Are we falling behind, or are we ahead of them in this respect? What is the role of monopoly in space research?

[Answer] The proceedings of the 26th International Geological Congress, held in Moscow in August of last year, help compare the level of Soviet and foreign work in space geology. On the whole, the levels of domestic and foreign development are close. However, we have moved ahead in compiling specialized maps and in systematic analysis of the entire set of space and geological materials to predict mineral deposits. A space geologic map of the USSR was exhibited successfully at the congress. This was the first time in world practice that such a map had been prepared. Therefore it attracted the attention of foreign scientists. By the way, Soviet geologists have compiled space geologic maps for a number of foreign countries on a contract basis.

The launch of the French "Spot" satellite is planned for the near future. In the United States a series of five "Landsat" satellites have been put in orbit for study of the planet's natural resources. In a recently published manual on remote methods American geologists write that a large volume of material also comes from spy photosatellites but all of this remains in the control of the Pentagon.

In the United States successful developments are being made in obtaining information from space in the thermal range of the spectrum and with use of

radars, as well as in certain areas of automated data processing. Recently in the United States there has been noted a tendency toward transfer of space research into the hands of monopolies, for example, the multinational oil companies.

[Question] Results in "space geology" are encouraging. In this connection it would be interesting to find out whether the traditional methods of research will disappear and the knapsack and the hammer, the old companions of geology, will be put aside.

[Answer] Of course not. Only now in addition to the hammer geology will have at its disposal the most modern geophysical instruments, drilling gear, the latest transport facilities and space data.

The use of space photos makes the labor of the geologist more precise and increases its results. It is not without good reason that more and more often people speak of geological survey production as one of the most important branches of the national economy.

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CSO: 1866/10

SPACE APPLICATIONS

AZERBAIJAN ORGANIZATIONS IN REMOTE SENSING RESOURCE STUDIES

Moscow PRAVDA in Russian 17 Jul 85 p 6

[Article by A. Pokrovskiy, special correspondent for PRAVDA, Baku, Mission Control Center: "The Waves of the Caspian--'Salyut-7': Our Commentary"]

[Text] In contrast to the sun, the "Salyut-7" orbiting station rises over our country from the west. And when the blue expanse of the Caspian Sea unfolds before the cosmonauts' eyes, if there is time, Dzhanibekov and Savinykh simply must look through the porthole.

"Now my Tashkent is near our course," notes the commander.

"Yes, and my native Urals aren't far off," the flight engineer responds.

Well, the cosmonauts have their own scales of measure. When the entire earth can be viewed in an hour and a half, everything really does seem nearby. But, nevertheless, the approach to the Caspian is special, because the name of the ancient sea [KASPIY in Russian] can be decoded as "Cosmic Apparatus for Spectral Investigation." For this young "Kaspiy" the tasks were global from the very beginning.

I remember how warmly Baku greeted the participants of the 24th International Astronautical Congress 12 years ago. It was difficult to choose from among the wide range of interesting talks. A wide range of problems on the development of cosmonautics was discussed. Soon it turned out that the discussions left their mark by more than just the transcribed minutes of the congress. The Azerbaijan Academy of Sciences drew practical conclusions from them.

We know that a Group for the Study of Jet Propulsion (BakGIRD) was active in Baku as in other cities in our country as early as 1932. In those days, it helped S.P. Korolev and his colleagues in the most natural way for oil-rich Baku--it produced concentrated gasoline for launching the first Soviet rocket, the GIRD-09.

Today mature Azerbaijani science has taken on even greater responsibilities. One has to admit that the republic's specialists have the right ideas about a field of orbital research still young in those days--space physical

geography. And they clearly established that Azerbaijan has virtually a full set of landscapes--from extensive seas to the glaciers of the Caucausus. A considerable amount of scientific and technical potential has built up in the field of instrument building and electronics. Such were the initial considerations in the creation in 1975 of a special "Kaspiy" Scientific Center under the Republic's Academy of Sciences. Its "older brother," the Institute for Space Research of the USSR Academy of Sciences, actively assisted in the center's scientific formation.

Was 10 years a long time for the development of a young scientific institution? Three years later, the "Kaspiy" served as the basis for creating the Institute for Space Research on Natural Resources, around which were grouped several design bureaus, a test plant for space instrument-building, and continental and marine control-and-measuring proving grounds.

The young organization was very serious about creating a theoretical concept for constructing systems for remote sensing of the earth and defining procedural, technical, and design-production principles for developing subsatellite systems. In a short time, the first automated system for aerospace proving grounds in the USSR was created.

Of course, the collective of one institute would not be capable of solving such large-scale problems. So Azerbaijani scientists took advantage of creative cooperation with the largest scientific organizations in the country. Agreements on scientific-technical cooperation were concluded, in particular with the Physics Department of Moscow State University, the Moscow Engineering-Physics and Aviation Institutes, the Astronomical Council of the USSR Academy of Sciences, the Institute for Radio Engineering and Electronics of the USSR Academy of Sciences, the Leningrad Physical-Technical Institute, and the Estonian Institute for Thermophysics and Electrophysics.

Representatives of countries which are members of the Intercosmos Program gathered last year in Azerbaijan to jointly approve techniques and equipment created in the fraternal states for remote sensing of the earth. "Salyut-7," the Soviet orbital laboratory, participated in the "Gyunesh-84" experiment. Thus, waves from the scientific impact of the "Kaspiy" spread to several countries. And it is very indicative that an eight-language terminological dictionary for specialists in socialist countries was created in Azerbaijan. It was published in Hungary and was intended to promote mutual understanding among scientists working in this new scientific discipline.

Such in brief is the scientific heritage created in the last 10 years. However, from its very first steps, space exploration was considered not only from a scientific, but a practical angle. This is a feature typical also of ground-based organizations involved in cosmonautics. This explains why, when the first Scientific-Production Combine for Space Research of the Azerbaijan SSR Academy of Sciences was founded 2 years ago based on the Institute for Space Study of Natural Resources and its related enterprises, more than a simple change of names occurred. At the same time, the economic significance of the combine's efforts was defined, and, moreover, it was assigned to focus on developing this direction in scientific-technical progress.

For example, it was only during the "Gyunesh-84" experiment that practical recommendations for developing the territory of the Ajinour Salt Lake were made on the basis of photographs from space and zones in which oak forest pests are spreading in the Shekinsk and Zakatal'sk regions of Azerbaijan were located.

The Scientific-Production Combine for Space Research cooperates closely with the republic's Ministry for Agriculture. For example, under the "Geobotanika" Program, aerospace methods were used to inspect virtually all summer pasture lands, and recommendations were given to improve them. The same procedures were used to compile a space-tectonic map of the Great Caucausus in just 1 year. Usually this work would take much longer.

But the Scientific-Production Combine for Space Research is not restricted to the boundaries of one republic. It does work in the Baltic and Primorsk Regions and on Kamchatka. It cooperates with the Institute for Water Problems of the USSR Academy of Sciences and the Institute of Microbiology and Virology of the Kazakh SSR Academy of Sciences. Thus, the contours of a new scientific discipline--regional space economics--being developed in the Scientific-Production Combine for Space Research are becoming more and more clear.

The Scientific-Production Combine's extensive facilities were shown to us by its general director, T. Ismailov (PhD), its assistant general director for scientific work, A. Mekhtiyev (PhD, physical mathematics), and the director of the Institute for Space Research on Natural Resources, A. Abdullayev (PhD, physical mathematics). The combine very carefully selects and then trains its personnel. Thus, Rafael Tagiyev came as a senior engineer and now heads the aerospace experiment laboratory. For him the route to the combine was natural--he studied under Ismailov at the Polytechnical Institute. And Anatoliy Gavrish came to Baku after finishing Riga Institute for Civil Aviation--he was attracted by this interesting new field of work.

"And now," says T. Ismailov, "we can train specialists right here at the combine. Azerbaijan University has organized a branch of its Astrophysics Department here and Azneftkhim, a branch of its Department of Information and Measuring Systems. Students will undergo special training and will defend their graduate work here. We are concerned also with training middle-level specialists for our production subdivisions. Therefore, we reached an agreement with the Republic Committee on Professional Education to establish a Professional Training Center."

And so, judging from all this, more than a little work will await the new specialists. It is worth noting that almost every communication from "Salyut-7" indicated that Vladimir Dzhanibekov and Viktor Savinykh were conducting studies in the interests of space physical geography.

"We don't mind spending time on this, even though we have other things to do," the crew commander said recently. "From space it is plain that the 'cradle of mankind' needs our care and protection."

This is precisely what the crew in orbit and the specialists on earth are working on.

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SPACE APPLICATIONS

SPACE PRODUCTION: TODAY AND TOMORROW

Moscow ZEMLYA I VSELENNAYA in Russian No 3, May-Jun 85 pp 65-68

[Article by S. D. Grishin, doctor of technical sciences, and L. V. Leskov, doctor of physical and mathematical sciences]

[Text]

K. E. Tsiolkovskiy was a man living much before his time, as a true and great scientist should.
-- S. P. Korolev

The writings of K. E. Tsiolkovskiy for the first time formulated and thoroughly validated a sequential program for the many-sided solution of the problems involved in the industrial exploitation of space. These matters already found reflection in his first scientific work entitled "Free Space," which K. E. Tsiolkovskiy wrote in 1883. K. E. Tsiolkovskiy dealt with the development of different aspects of the problem of industrialization of space during virtually his entire creative life ("Investigation of Universal Space by Jet Instruments" -- 1903, 1911 and 1926; "Future of Earth and Mankind" -- 1920; "Monism of the Universe," "The Cause of Space" -- 1925; "Organic World of the Universe" -- 1925-1928; "Objectives of Star Navigation" -- 1929; "Maximum Rocket Velocity" -- 1935).

But only in our time did it become possible, from the practical point of view, to examine the grandiose problem of industrial exploitation of space which was brought to the forefront by K. E. Tsiolkovskiy. In order to make this more graphic we prepared a table of the principal directions in space industrialization.

Examining the table, it is easy to note that the status of work along different lines of space industrialization is at different stages. Some space systems are already widely in use in the national economy and have a quite high technical-economic efficiency; with respect to others, theoretical and experimental research is being carried out on a wide front; still others for the time being are in the stage of active research planning. At the same time, despite the different technical level of solution of specific problems in the industrial exploitation of space there are more than a few general problems whose successful solution will greatly govern progress in all the mentioned directions.

These include the development of promising transportation-power space systems, highly efficient and economical power converters and the development of optimum space technology methods.

The section "K. E. Tsiolkovskiy and Space Production Problems" was organized in 1980 within the framework of the readings devoted to the development of the scientific heritage and development of the ideas of K. E. Tsiolkovskiy. The work objectives of this section include: 1) presentation of generalizing scientific reports on specific aspects and problems of space production; 2) presentation of reports on general problems (space transport systems, energy conversion, space technology, etc.); 3) determination of the prospects for work in the field of industrial exploitation of space. The authors of the reports devoted particular attention to the thorough development and creative development of the ideas of K. E. Tsiolkovskiy.

Section sessions were carried out in the years 1980-1984 within the framework of the 15th-16th Tsiolkovskiy Readings. The problems relating to the subject matter of the section were taken up in the plenary sessions of the readings in 1980, 1981 and 1984. A report by V. S. Avduyevskiy, S. D. Grishin, L. V. Levskov and A. F. Yevich (15th Readings) was devoted to the problems related to the development of the ideas of K. E. Tsiolkovskiy on the industrialization of space. The report gave an analysis of the status and prospects for work on establishing space solar electric power stations and examined the fundamental possibilities of constructing a new class of transport systems based on the use of laser technology.

The designing of electric rocket engines at the present stage was the subject of a report by S. D. Grishin and L. V. Leskov (16th Readings); it was demonstrated that it is feasible to use them for studying the solar system. It is well known that the idea of constructing engines of this class was advanced for the first time by K. E. Tsiolkovskiy and that the first engine of such a type was constructed by V. P. Glushko.

At the 19th Readings Yu. A. Izrael, A. A. Afanasyev, S. D. Grishin and Yu. V. Novikov gave a report devoted to investigation of the anthropogenic state of the earth from space vehicles. The report examined the problems involved in the space monitoring of anthropogenic effects on the natural environment, including observation of the factors which determine its pollution, and also evaluation and prediction of the state of the environment.

Now we will discuss some reports which were read at the section meetings. A report by S. D. Grishin, L. V. Leskov and V. V. Savichev was devoted to the problems of the physics of weightlessness as a scientific foundation of space production. It gave the results of experiments carried out on the "Salyut-6" station by means of the "Pion" instrument during which a study was made of the peculiarities of the processes of heat and mass exchange during weightlessness. The determination of the level of residual accelerations aboard an orbital station is of great importance for the correct formulation of technological experiments. The results of a corresponding metrological investigation were given in a report by S. S. Obydennikov and others.

Directions in Space Industrialization

	Complex systems	Direction in industrialization	Present status	Unsolved problems
1.	Space information systems	1) space communication systems; 2) satellite meteorology; 3) satellite navigation; 4) space monitoring and preservation of environment; 5) space geography; 6) space mapping and exploration for minerals; 7) marine fishing	Developed and used in space systems for national economic purposes	Development of comprehensive data systems, banks of scientific and technical data with use of space systems. Increase in efficiency of economic use of space data systems.
2.	Space construction and production	1) Technology of assembly and erection work in space	Practical work has begun in space (on "Soyuz-6" in 1969, work of G. S. Shonin and V. N. Kubasov with "Vulkan" apparatus; on "Salyut-7" and others	Development of complex of equipment and technical apparatus for use in space for assembly and erection of large structures
		2) Production of new and improved materials in space	Technological experiments have been carried out on manned and automatic space vehicles	Formulation of scientific principles of space production. Development of on-board technical complexes for production of materials
		3) Use of extraterrestrial resources	Long-range research	Optimization of transport-power systems

Directions in Space Industrialization (continued)

	Complex systems	Direction in industrialization	Present status	Unsolved problems
3.	Production of high energies in space	1) Space solar power stations	Long-range research Testing power transformation systems	Development of highly efficient and economical power transformers. Transport systems. Erection methods
		2) Space optics and power transmission lines	Long-range research Testing of components	Development of light film concentrators. Methods for their assembly. Development of space transportation systems. Optimum construction of systems for transmission and use of energy
		3) Promising space transportation systems	Long-range research Checking of principles for constructing new space transportation system	Changeover from thermochemical methods for generating thrust to new principles for constructing space transportation systems

A report by S. V. Gurevich and his colleagues examined the prospects for use of holographic methods in space technology. The report of L. A. Slobozhanin was devoted to the problems involved in hydrostatic stability when carrying out zone melting. I. V. Barmin, L. V. Leskov and their colleagues developed a method for preparing optimum programs for technological experiments.

A series of reports by V. S. Zenskov, M. R. Raukhman, V. T. Khryapov, Ye. V. Markov and others gave the results of technological experiments for producing semiconductor materials aboard the orbital stations "Salyut-6" and "Salyut-7." It was established in these experiments that the preparation of semiconductor materials under weightlessness conditions makes possible a considerable improvement in their indices in comparison with terrestrial analogues. The reports of M. S. Agafonov and others told about obtaining improved materials by the accelerated crystallization methods under conditions of brief weightlessness.

Another important direction in the production of materials in space, space metallurgy, was the subject of reports by Ye. M. Savitskiy, B. P. Mikhaylov and others. It is shown, in particular, that there are fundamental possibilities for improving the properties of superconducting and magnetic alloys. Yu. V. Chemlya examined the prospects for space production of alloys with an oriented eutectic structure. V. P. Nikitskiy and G. V. Zhukov analyzed the problems involved in the preparation of thin films and coatings using apparatus of the "Isparitel" type.

A number of reports were devoted to the space preparation of biologically active substances which can find practical use in public health. Also discussed were bioengineering experiments carried out on the "Salyut-7" station.

Another important scientific direction in space production which was examined at the section sessions was space generation of high energies. A central place in the cycle of research studies carried out was occupied by the problems involved in constructing space solar electric power stations (SSPS) intended for supplying power to the earth. In this case the attention of researchers was concentrated on the following basic problems: general principles of construction and choice of an optimum base model of a SSPS; efficient converters of solar radiation energy and converters used in the receiving-transmitting complex; effect on the ambient medium; technical-economic efficiency of power supply to the earth using a SSPS. With respect to all the enumerated problems substantial progress has been made as a result of the research carried out.

The reports of V. M. Lopukhin, V. A. Vanke and his colleagues successively examined the present status of research and gave an overall evaluation of the prospects of SSPS. N. S. Lidorenko analyzed problems related to space power production and the prospects for fabricating highly efficient photoconverters.

The reports of N. A. Armand, L. V. Dubovoy and others were devoted to the problems involved in the conversion of electric power into the power of microwave radiation. The possible effect of microwave radiation on the earth's

ionosphere was examined by V. V. Belyy and others. The principles for optimum construction of a receiving-converting complex for microwave radiation on the earth were set forth in reports by V. A. Vanke, A. S. Gvamichava, V. A. Kolobov and others.

Another group of reports gave an analysis of optimum methods for constructing space power systems (S. D. Grishin, A. F. Yevich, Ye. A. Narimanov and others). The reports of Yu. P. Semenov, G. G. Bubnov, D. D. Sevruk and his colleagues dealt with the problems involved in the optimization of the specific weight characteristics of SSPS and their parameters on the basis of technical-economic criteria.

The aspects of the problem of space fabrication of precise reflecting surfaces were analyzed by A. S. Gvamichava and others. A. V. Lukyanov studied a problem close to the SSPS problem: developing space optical systems, concentrators of solar radiation, intended for illumination of regions on the earth's surface.

In order to ensure further progress in the three leading directions in space production (space information systems, production of materials, space power), work must be done on development of efficient and economical space transport systems and improvement in methods for the space installation and assembly of large-dimensional structures. For this reason great attention was devoted to these problems at the section sessions.

Many reports were devoted to the optimization of freight transportation in the exploitation of circumterrestrial space, including industrial use of the moon. V. S. Avduyevskiy and others considered the prospects for constructing a carrier-rocket to which power is supplied from a SSPS by a laser beam of great power. S. D. Grishin and L. V. Leskov in their report discussed the possibility of using electrical rocket engines for flights within the limits of the solar system.

In the opinion of B. A. Osadin, electromagnetic mass accelerators will find use in those cases when considerable payloads must be put into space. The possibilities of using a solar sail for interorbital freight transport were examined by A. V. Lukyanov. I. R. Kuznetsov and others demonstrated how electric rocket engines can be used in constructing a special space vehicle for the production of improved materials aboard which the level of residual accelerations will be minimum.

During the years 1980-1984 there was a constant increase in the number of reports devoted to the problems involved in the assembly and installation of large structures in space. This is evidence of the practical direction in research in the field of space production. The reports of A. S. Gvamichava, A. S. Sokolov and others studied the weight characteristics of different types of space constructions for the purpose of choosing the optimum principles of their construction and analyzed different methods for constructing large antenna systems and the requirements on the accuracy of constructing their supporting frames. The authors of other reports dealt with the prospects for use of transforming panels and shells in the construction of space

objects, different methods for coupling three-dimensional structures and the use of gas cutting.

N. F. Kazakov and his co-workers proposed the use of diffusion welding methods for the assembly of large space structures. The great prospect of these methods is determined by the fact that they ensure a simple and reliable coupling of metallic and nonmetallic materials, do not require high temperatures and can be employed in a space vacuum.

O. S. Tsygankov and others in their reports examined the problems of the instruments and tools used in assembly-installation and repair-reconstruction work in space, the development of autonomous electromechanical fixation systems on the basis of permanent magnets, and also design problems in the development of space equipment.

A number of reports were devoted to the modeling of industrial operations in space with use of a hydromedium (Yu. N. Glazkov, V. I. Bachurko and others). These methods have found use, in particular, in the testing of technological operations for increasing the area of the solar cells on the "Salyut-7" orbital station for the purpose of increasing electric power.

At the section there were also discussions of reports which dealt with the principles for preparing long-range predictions for the industrial exploitation of space, the stages in setting-up space production and the possible influence of new advances in the physical-technical disciplines on space industrialization (S. D. Grishin, L. V. Leskov).

The further activity of the "K. E. Tsiolkovskiy and Space Production Problems" section will be directed to the many-sided study and creative development of the ideas of K. E. Tsiolkovskiy on the industrial exploitation of space in the interests of mankind.

5303
CSO: 1866/8

SPACE APPLICATIONS

UDC 621.396.96:551.25+629.78

RADAR OBSERVATIONS OF RIVER OVERFLOWS FROM OUTER SPACE

Moscow DOKLADY AKADEMII NAUK SSSR in Russian Vol 284, No 2, Sep 85 (manuscript received 24 May 85) pp 323-326

PICHUGIN, A.P., GAVRILENKO, A.S., GRIBUNIN, A.G., YELENSKIY, L.V., KALMYKOV, A.I. and Academician (UkSSR Academy of Sciences) SHESTOPALOV, V.P., Institute of Radiophysics and Electronics, UkSSR Academy of Sciences, Kharkov

[Abstract] Reliable data about overflow of rivers and resulting flooding of river valleys have been obtained from observations made by the "Cosmos-1500" satellite with a side-looking radar. Reconstructed pictures of the Amur River and its valley on 20 August 1985 accurately reveal flooded and dry areas, corresponding respectively to darker and brighter spots on these radar maps. SLR is particularly helpful here, inasmuch as dry land has a larger specific effective scattering area than water and therefore returns a stronger echo signal when the incidence angle of the signal is $\theta \gtrsim 15°$. Actually, three zones are distinguishable on these maps, moderately flooded surfaces as well as maximally flooded and dry ones. Such observations are consequently useful not only for monitoring the overflow of rivers, which includes delineation of flooded territory, but also for forecasting changes in conditions and for drainage control. A special program for computer-aided processing of intensity signals in the dialog mode has been devised, with the value 255 in byte format assigned to all signals of higher than a given threshold intensity and the value 0 assigned to all others. The algorithm is based on interpretation of the measured backscattering characteristics of surfaces and the contrast characteristics of reflected radar signals. The authors thank B.D. Zamarayev, V.B. Razskazovskiy and G.P. Kulemin for helpful discussions. Figures 3; references: 9 Russian. [9-2415]

UDC 551.521

VARIABILITY OF ATMOSPHERIC TRANSFER FUNCTION COMPONENTS

Moscow ISSLEDOVANIYE ZEMLI IZ KOSMOSA in Russian No 4, Jul-Aug 85 (manuscript received 21 Jun 84) pp 9-20

POKROVSKIY, O.M., PROKHOROV, V.M. and PCHELOVA, T.F., Main Geophysical Observatory imeni A.I. Voyeykov, Leningrad

[Abstract] In order to make practical use of data from a multichannel space survey it is important to be able to determine the composition and state of environmental features on the basis of their spectral reflectivity. By a determination of the relationship between spectral albedo and coefficients of spectral brightness of natural features and their physical, chemical and biological characteristics it is possible to formulate inverse problems in evaluating the state of such objects on the basis of the results of optical measurements. The accuracy in solving such inverse problems is low. However, there is another approach involving tabulation of the components of the atmospheric transfer function on the basis of the most precise methods for numerical solution of the radiative transfer equation for a relatively broad range of realistic (primarily aerosol) models. The authors have used this second approach, applying the most recent advances in atmospheric optics, such as a highly accurate numerical method and aerosol model, in the most rapid possible processing of multichannel space information. The article gives the results of computations of components of the atmospheric transfer function in the range 0.4-0.9 μm in which the basic variability factor is the aerosol optical thickness, varying particularly strongly in the boundary layer. The sensitivity of the angular dependence of the transfer function to variations in the optical characteristics of aerosol was studied, making it possible to ascertain the sighting conditions under which the influence of the atmosphere on the results of spectrometric measurements is minimum. Figures 4, tables 6; references 15: 7 Russian, 8 Western.
[119-5303]

UDC 551.521.16

OPTICAL THICKNESS OF ATMOSPHERIC AEROSOL OVER SEA

Moscow ISSLEDOVANIYE ZEMLI IZ KOSMOSA in Russian No 4, Jul-Aug 85 (manuscript received 1 Nov 84) pp 21-30

SHIFRIN, K.S., VOLGIN, V.M., VOLKOV, B.N., YERSHOV, O.A. and SMIRNOV, A.V., Leningrad Division, Oceanology Institute imeni P.P. Shirshov, USSR Academy of Sciences; Leningrad Hydrometeorological Institute

[Abstract] A knowledge of the aerosol optical thickness $\tau_a(\lambda)$ of the atmosphere over the sea is required for developing methods for remote sensing of the ocean from space. On the basis of $\tau(\lambda)$ values, solving the inverse problem, it is also possible to study the mean microstructure of aerosol in a vertical column of the atmosphere. In order to determine the structure of the $\tau_0(\lambda)$ spectra for the "marine" atmosphere it is necessary to make detailed measurements for different physiographic conditions. This makes it desirable that there be a systematic study of the properties of $\tau_a(\lambda)$ over the sea. The article gives the results of such investigations. A special measurement complex was developed for measuring $\tau_a(\lambda)$. It consisted of two spectrophotometers and a recording block with the output of the measurement results in a digital code. The use of two instruments made it possible to carry out measurements in a broad spectral range (369-1016 nm). The $\tau(\lambda)$ value was determined by the Bouguer method. The error in photometric measurements and registry for the first instrument was 3%, for the second about 1%. The results of the measurements are given in the form of two groups of data. The first includes 35 series of measurements which were made from scientific research ships in different regions of the world ocean during the period from June 1982 through November 1983. The second group includes measurements on the Black Sea coast in the neighborhood of Cape Pitsunda in October 1983. The data reveal that despite a considerable variability of aerosol optical thicknesses, they correlate well in the visible and near-IR regions. Regression equations are given which can be used in remote sensing of the ocean. Figures 2, tables 6; references 8: 6 Russian, 2 Western.
[119-5303]

UDC 528.88:551.243.13

NEW METHOD FOR GEOLOGICAL INTERPRETATION OF ANNULAR STRUCTURES WITHIN COVERED AND PARTIALLY COVERED AREAS

Moscow ISSLEDOVANIYE ZEMLI IZ KOSMOSA in Russian No 4, Jul-Aug 85 (manuscript received 21 Jul 83, after revision 11 Sep 84) pp 31-40

ZEYLIK, B.S., PERFILYEV, L.G., VASILENKO, A.N. and SEYTMURATOVA, E.Yu., Kazakhstan Experimental-Methodological Expedition, Alma-Ata; Geological Sciences Institute imeni K.I. Satpayev, Kazakh Academy of Sciences, Alma-Ata

[Abstract] Surveys of the earth from space have revealed an abundance of craters in areas where they had never been suspected and which escaped attention even in large-scale geological surveys. Such a territory is the area northwest of Lake Balkhash, surveyed in winter before sunset from the "Salyut-4." In oblique solar illumination it is easy to discriminate craters which to an adequate degree retain their morphological features and annular structures characterized by arcuate and radial faults. These craters are of meteoric origin. These crater structures may be partially or completely covered by unconsolidated sediments, but they still are detectable in oblique sunlight. Detection of such structures can be regarded as a new and promising direction in prediction and exploration work since significant mineral deposits may be associated with them. Such surveys must be made in definite time intervals: in the morning they must begin no sooner than 1 hour 18 minutes after sunrise and must end no later than 1 hour 42 minutes after sunrise (surveys can last no more than 24 minutes). At the latitude of Central Kazakhstan at this time the solar zenith angle is 74-80°. At such zenith angles there is a maximum "lunar landscape" effect. Many weather complications (clouds, morning and evening fogs) can interfere with such surveys. In actuality, a detailed interpretation requires oblique illumination from all possible angles. However, under natural conditions only two directions can be used--from the east at sunrise and from the west at sunset. A proper survey would require the appearance of a spacecraft over stipulated territories at a very definite time. In this article it is shown that all these limitations are removed by special modeling. Several modeling methods are possible, the best being formulation of mathematical models using a computer. A detailed illustration of application of this approach reveals the great advantages of the mathematical modeling method in automating the process of interpretation of materials from remote surveys. Figures 6; references: 16 Russian.
[119-5303]

UDC 631.4:629.78

STUDY OF SPATIAL STRUCTURE OF SOIL COVER IN BAYKAL REGION USING AEROSPACE PHOTOGRAPHS

Moscow ISSLEDOVANIYE ZEMLI IZ KOSMOSA in Russian No 4, Jul-Aug 85 (manuscript received 10 May 84) pp 53-57

KUZMIN, V.A., Geography Institute, Siberian Department, USSR Academy of Sciences, Irkutsk

[Abstract] The soil cover is undergoing strong changes in Eastern Siberia in the neighborhood of construction of the Baykal-Amur Railroad, hydroelectric power stations and other projects. The soil cover and its changes can be studied best by using aerospace materials. It is best that soil regions be defined on photographs at 1:2,500,000. An example of a soils geography regionalization map, compiled from photographs at this scale, is illustrated. It shows provinces and regions. Regions are defined within the limits of plateaus, plains, high, intermediate and low mountains and basins. Photographs at 1:1,000,000 yield considerably more information; in addition to provinces and regions it is possible to define "landscape" units. Among the different photographic scales used the most detailed were "intermediate-scale" photographs on which it is possible to discriminate "districts," soil micro- and mesostructures and elementary soil areas. In contrast to space photographs (on which it is possible to discriminate the relationship between the soil cover and macrostructures, slope exposure and morphosculptures) on aerial photographs it is possible to discriminate vegetation, micro- and meso-relief, and in cultivated areas such soil characteristics as humus content, moisture content, calcareousness, etc. In the study of soils geography the soil cover is reflected through the structure of different levels of organization. Figures 3; references: 4 Russian.
[119-5303]

UDC 639.1.0+629.195.1+528.74:59

GAME HABITAT EVALUATION USING MICROPHOTOMETRIC MEASUREMENTS ON AERIAL PHOTOGRAPHS

Moscow ISSLEDOVANIYE ZEMLI IZ KOSMOSA in Russian No 4, Jul-Aug 85 (manuscript received 17 Apr 84) pp 58-64

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[Abstract] The authors examine the fundamental principles for automated interpretation of aerospace photographs in relation to a qualitative evaluation of forest habitats of herbivorous mammals. The work was done on the basis of the microphotometric method, making it possible to develop a basis for the interpretation of game habitats using available photo image processing

systems. The objective was the preparation of programs for processing of data on electronic computers and use of more complex scanning systems. Game habitats were evaluated in two test ranges (subtaiga zone of pine forest and in mountain foothills). Aerial photographic surveys were made at 1:15,000, 1:40,000 and 1:100,000 in March-April when woody vegetation stood out in contrast against the snow cover. The microphotometer used made it possible to obtain the photo image density characteristics in 250 gradations. The influence of rate of registry, instrument aperture size and shape on the nature of the trace was studied. The office measurements were preceded by field work for determining the food and protective resources of the most common types of vegetation which were interpreted on the photographs. Tone, structure and pattern of the black-and-white photo image were used as the interpretation criteria. The photo image density of game habitats reflects their specific ecological characteristics. The microphotometric procedures make it possible to obtain these characteristics in the form of a trace and a digital series. The use of a special evaluation grid provides a reliable qualitative evaluation of food and protection in such habitats. The proposed method considerably reduces the volume of manual work in office and field procedures in forest management. The continuous receipt of information in the form of space photographs makes it possible to monitor the dynamics of game habitats. Figures 2, tables 1; references 9: 7 Russian, 2 Western.
[119-5303]

UDC (528.77:535.24):629.78

RADIATION CORRECTION FOR AEROSPACE IMAGES OF AGRICULTURAL CROPS

Moscow ISSLEDOVANIYE ZEMLI IZ KOSMOSA in Russian No 4, Jul-Aug 85 (manuscript received 7 Sep 84) pp 78-85

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[Abstract] A radiation correction is introduced into aerospace images for increasing the accuracy in solving problems involved in identifying the spectral images of natural features. Since most problems in the processing and analysis of aerospace information in the interests of agriculture are based on specially developed classification procedures (A.I. Belchinskiy, ISSLED. ZEMLI IZ KOSMOSA, No 5, pp 5-11, 1982), the real possibilities of use of the radiation correction procedure can be evaluated with their joint use in problems of the classification and identification of objects. The article describes a procedure for the forming of model aerospace images of agricultural crops by the superposing of atmospheric noise, represented in the form of a set of coefficients for approximating radiation intensity by orthogonal polynomials. The effectiveness of elimination of noise of this type is demonstrated. A classification of model images of agricultural crops before and after correction of atmospheric distortions is presented. The

influence of atmospheric distortions on the accuracy of classification of agricultural crops is analyzed for stipulated states and nonorthotropicity of reflection under fixed survey conditions. When introducing a radiation correction and applying cluster analysis the mean accuracy of the classification is increased by 8.6%. The practical introduction of the results requires solution of the following problems: representation of image elements in absolute measurement units; determination of the actual state of the atmosphere at the time of the survey; evaluation of the real sensitivity of the radiation correction computation scheme to variations in the state of the atmosphere with a possible decrease in the sets of approximation coefficients used in retrieving albedo of the earth's surface. Recommendations are given on how to solve these problems. Figures 6; references 20: 14 Russian, 6 Western.
[119-5303]

UDC 535.243.25:519.22+629.78

IDENTIFICATION OF NATURAL FORMATIONS FROM RESULTS OF SPECTRAL-ENERGY MEASUREMENTS FROM SPACE

Moscow ISSLEDOVANIYE ZEMLI IZ KOSMOSA in Russian No 4, Jul-Aug 85 (manuscript received 30 May 84) pp 98-104

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[Abstract] The problem of identifying natural features on the basis of their spectral-energy characteristics measured at the upper boundary of the atmosphere was studied. Particular attention was given to choice of the number of spectral criteria ensuring a minimum probability of error in the classification of features. The dependence of the reliability of the classification on sample volume was investigated. The basis of the study was data from spectrometric observations of the earth's surface in the range 0.4-0.8 μm obtained with a MSS-2 spectrometer from the "Salyut-4." The investigated features were green vegetation zones, deserts and rock outcrops, water surfaces and dense cloud cover. All the data were obtained during the daytime. Several tens of experiments were carried out over uniform surface sectors when there was a cloudless atmosphere. A teaching sample of 625 independent observations was formed which included 168 measurements of green steppe, wooded steppe and forest on the Russian plain and in Kazakh folded country, 154 measurements of desert and rock outcrops in the territory of the Kazakh folded country, Russian plain and other regions, 131 measurements over seas and oceans and 172 measurements of dense cloud cover. It was found that despite the fact that all parts of the spectrum carry a definite quantity of information, an increase in the number of spectral intervals used does not always result in an improvement in the reliability of identification of features. The authors propose use of a new modification of multichannel optical recognition systems differing from those in existence in that there are in each of the channels wide-band light filters

with spectral transmission coefficients different from zero in the entire working region of the instrument spectrum instead of narrow-band light filters forming individual nonoverlapping or contiguous spectral intervals. A merit of such apparatus will be not only a possible decrease in the number of channels, but also a considerable decrease in the noise level and an increase in instrument light flux response. Figures 4, tables 2; references: 12 Russian.
[119-5303]

UDC 535.243.25:519.22+629.78

CLASSIFICATION OF NATURAL FORMATIONS BASED ON THEIR OPTICAL CHARACTERISTICS USING SMALL VOLUMES OF SAMPLES

Moscow ISSLEDOVANIYE ZEMLI IZ KOSMOSA in Russian No 4, Jul-Aug 85 (manuscript received 14 Nov 84) pp 105-111

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[Abstract] The article validates and develops an algorithm for the classification and choice of informative criteria for identifying natural features from their spectral-energy characteristics registered from space when using small-volume samples. The basis for the study was experimental data obtained using an MSS-2 spectrometer carried aboard the "Salyut-4." Specially developed methods and programs were used in studying the spectral characteristics of different types of terrestrial surfaces. From the entire mass of data, about 100,000 spectra, those materials are selected which were obtained in summer at the time of cloudless weather over individual objects, physiographic zones and provinces, which in turn, were divided according to spectrum type into classes in accordance with the spectral classification of natural features formulated by Ye.A. Krinov and K.Ya. Kondratyev. The identification of natural features from space requires application of statistical decision rules effective with both a normal and a nonnormal law of distribution of spectral characteristics. The selected classifiers must take into account the interdependence of criteria. It is necessary that the method ensure rapid convergence in the search for the best subsystem of criteria in the sense of maximizing of reliability in the identification of objects and also the reliability of the results in the case of both large and small samples. The algorithm given in the article meets these specifications. Application of the algorithm is illustrated in the example of identification of different types of green vegetation. Figures 2, tables 2; references: 14 Russian.
[119-5303]

UDC 528.813+631.1

ALLOWANCE FOR PROPERTIES OF BOUND MOISTURE IN REMOTE SENSING OF SOIL MOISTURE CONTENT

Moscow ISSLEDOVANIYE ZEMLI IZ KOSMOSA in Russian No 4, Jul-Aug 85 (manuscript received 4 Jun 84) pp 112-115

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[Abstract] As a result of change in the moisture content and thermodynamic temperature of the soil with depth, moist soil is an electrically inhomogeneous medium. A change in moisture content is reflected in a change in emissivity and the absorption coefficient. Due to the great difference in the permittivity of solid soil particles and water it is possible to make remote measurements of soil moisture content. The permittivity of firmly bound moisture is very small and its contribution to the permittivity of moist soil is small. In remote determination of soil moisture content it is necessary to take into account the properties of the bound water or the determined moisture content values will be too low. The error in determining moisture content will be the greater the more finely dispersed is the soil. The best accuracy in remote sensing of moisture content is 15%. This accuracy is inadequate for determining the moisture content of poorly moistened soils. The article is limited to examination of the dielectric properties of bound moisture, allowance for which makes it possible to determine soil moisture content on the basis of measured T_{br} twice as accurately as before. In order to solve the problem of more precise determination of moisture content on the basis of measured brightness temperature it is necessary to have a map of soil types, and for the particular soil type to have data on characteristic w_t (moisture content corresponding to the curve transition point) and data on ε_x values (permittivity of bound water) for known w_t, including the spectral dependence of the permittivity of bound water. This necessitates cataloguing of w_t values and ε_x values, related to w_t, for soils of different textures. Figures 1, tables 2; references 11: 8 Russian, 3 Western.
[119-5303]

SPACE POLICY AND ADMINISTRATION

THE EXPLORATION OF OUTER SPACE AND THE DEVELOPING COUNTRIES

Moscow ZEMLYA I VSELENNAYA in Russian No 4, Jul-Aug 85 pp 76-81

[Article by Candidate of Historical Sciences S. M. Monin in "Cosmonautics Abroad" section]

[Text] Over the last few decades space exploration has acquired unprecedented scope. The developing countries, too, are getting more and more actively involved in this process.

New Opportunities

In many countries of Asia, Africa and Latin America ground communications systems still do not adequately cover large areas, and space technology is frequently the simplest and fastest means of setting up communications between regions within countries as well as with the outer world. It is not accidental that in 1981 the share of developing countries in the use of space communications satellites increased to approximately 35 percent, whereas 15 years ago it had been virtually zero. Space television can play an important part in overcoming illiteracy and raising the general educational and cultural standards of the people of such countries. Data received from outer space on meteorology, the state of farmlands and forests, and mineral deposits can facilitate the development of agriculture and the extracting industries, which constitute the developing countries' economic basis. Of considerable importance are navigation support, oceanic studies, and monitoring the environment.

However, there are serious obstacles on the road of the developing countries' active participation in space exploration. The development and operation of space hardware is extremely expensive. In most cases the level of industry, science and technology is not high enough. There are few experts capable of contributing to space projects. It is not surprising, therefore, that these countries account for only 5 percent of space-related world research and development. Few developing countries have been able to undertake independent space programs.

India in Space

India has advanced farther than the others in the exploration of outer space. The first serious work on space research began there back in the late 40s. It has especially gained in scope since the 60s. Special scientific organiza-

tions have been set up for space research, and a scientific and technical program is being drawn up. From the outset the Indian space program was oriented on achieving independence in space exploration and gearing it to the needs of the national economy and culture.

When Indian scientists were just embarking on serious space research quite a few people both in and outside the country were highly skeptical. Why, they asked, should India, where so many people still live in poverty and which has a long way to go to overcome her social, economic and cultural backwardness, divert funds for space research? The well-known physicist and Nobel Prize Laureate, Ch. V. Raman, declared that space flight had only military applications for the great powers and that for India such programs were but a needless and burdensome waste of money.

Life, however, has disproved the skeptics. After gaining independence, India built up a large industrial and scientific potential. The country joined the ten leading industrial powers of the world. Only the Soviet Union and the United States are ahead of her in number of engineers and technicians. Already by the 1960s, one out of every 40 scientific discoveries in the world was made by Indian scientists.

Space-related R&D is conducted under the auspices of the Indian Space Research Organization (ISRO), which has a staff of 13,000. Expenditures for the space program, according to the FAR EASTERN ECONOMIC REVIEW, exceeded $250,000,000 in 1974-1979, and more than $400,000,000 have been allocated for 1980-1985. India has built two space launching centers, in Thumba, near Trivandrum on the west coast, and at Sriharikota, north of Madras. She has well-equipped research institutes, design offices and plants for the manufacture of space hardware (see ZEMLYA I VSELENNAYA No 5, 84 p 44--Ed.).

Since 1967, when India launched her first meteorological rocket (a mere 75 mm in diameter), she has followed up with her first earth satellite, the Aryabhata, which was orbited in 1975 by a Soviet rocket. In 1980, India became the seventh nation in the world (and the first of the developing countries) to acquire a capability for launching her own satellites. On 18 July 1980, the four-stage solid-fuel rocket SLV-3 placed the 35-kilogram satellite Rohini-1 into orbit. More satellites launches in the Rohini series followed in 1981 and 1983.

The space program has begun to yield practical fruit. The words of Indian Prime Minister Indira Gandhi, who had compared the costs of space exploration with the costs of educating children because the results are not immediately apparent, have come true.

In such a vast country as India the best way of expanding communications is through the use of satellites. It has been estimated that the cost of a national space TV system would be one-fifth of an equivalent land system. Experimental educational telecasts carried out in the latter 70s via American and French-West German satellites yielded good results. The majority of India's population is illiterate. It was therefore proposed that a special "educational" satellite be developed. In accordance with a program providing for the establishment of a national space communications system, in the early

80s the experimental satellite Apple was launched by a rocket of the European Space Agency, followed by satellites of the Insat series designed in India but built and orbited by the United States under commercial contract.

Data obtained from outer space help make more accurate weather forecasts, thus lessening, for example, the damage caused by monsoons, which runs up to $200,000,000 a year. Satellites provide valuable information for agriculture and forestry, made even more valuable by the fact that so far only one-fifth of all arable land has been seriously studied. Great hopes are being placed in mineral prospecting and observing many natural processes from outer space.

The 1985-1990 program, for which more than $1.5 billion is being appropriated, provides for accelerating the transition from experimental to operational space systems. Plans call for completing the development and carrying out the first launches of a new rocket, the ASLV (Augmented Satellite Launch Vehicle) capable of placing satellites weighing up to 150 kg in orbit, as well as the PSLV (Polar Satellite Launch Vehicle) for placing vehicles weighing up to 1,000 kg in heliosynchronous orbit.

The Soviet Union was the only country to fully support India's desire to independently explore and utilize outer space. V. Sarabhai, one of the pioneers of the Indian space program, was right when he stressed, "If we need help in space technology we will turn to the Soviet Union. We need not only satellites but also the no-how to build them, space technology, and only the Russians can give us such help."

Soviet-Indian cooperation in space exploration has been developing successfully along all the main lines for more than 20 years. Soviet experts assisted in developing satellite design and scientific instrumentation and in building ground flight control centers. Indian scientists were given samples of moon soil. The Indian satellites Aryabhata (1975), Bhaskara-1 (1979), and Bhaskara-2 (1981), were launched from Soviet territory by Soviet rockets, and the Soviet Union supplied some of the equipment for them. Another satellite launching is planned for 1986. The high point of the two countries' collaboration in outer space was the Soviet-Indian expedition aboard the orbital station Salyut-7 in April 1984 (see ZEMLYA I VSELENNAYA No 5, 84 pp 44-50--Ed.). Work on joint projects makes it possible to accelerate implementation of India's national space program.

Outer Space is for All

Another country embarking on space exploration is Brazil. Over little more than 20 years it has built up a fairly advanced space industry. In November 1984, Brazil launched its first carrier rocket, the Sonda-4, the last stage of which reach an altitude of 630 km. In February 1985, the satellite Brazilsat was launched by the Ariane rocket from the Kourou launch center in French Guiana. It has a capability of simultaneously carrying telecasts over 24 channels and 12,000 telephone conversations. In the late 80s and early 90s, four satellites built almost completely in Brazil are to be launched. The costs of their launching by a Brazilian rocket will be approximately $200,000,000.

So far the overwhelming majority of developing countries are restricted to whatever they can obtain from bilateral or multilateral cooperation with more developed countries. Dozens of developing countries are participating in such international programs as the Intelsat space communications system, the Landsat remote earth sounding system, and the Inmarsat marine satellite communications system. Thus, Thailand has used Landsat data to study floods and build a drainage system, and the Philippines used it to compile a more detailed map of forest resources, which would have been impossible by conventional means. In many countries satellite tracking stations have been built and are operating in the framework of those programs.

Several developing countries are purchasing space hardware, notably communications satellites. In 1976-1977, the United States built and launched two Palapa-A satellites for Indonesia. Together with the ground equipment, they cost almost $100,000,000. Since 1979, the Philippines, and then Malaysia and Thailand, have been leasing available capacities of those satellites for their domestic needs. The next generation of Palapa-B satellites, due to go into operation in the mid 80s, will be capable of providing different types of communication not only for Indonesia, but for other ASEAN countries and Papua-New Guinea.

In 1976, members of the Arab League set up their Satellite Communications Organization. Its two satellites were designed to provide the Arab world with telephone, telegraph, telex, and television communications. In February 1985, the Arabsat satellite was launched by an Arianne rocket from the Kourou space center in French Guiana. It will cover the territories of most Arab countries and can handle 8,000 telephone and telex lines and eight TV channels. In the beginning of 1985, Egyptian scientists completed preparatory work for the launch of the first Egyptian satellite. The possibility of acquiring communications satellites has been considered by Argentina, Nigeria, South Korea, and the Andean Pact countries (Bolivia, Venezuela, Columbia, Peru, and Ecuador).

Forced to constantly seek technical assistance and information from the space powers, the developing countries are especially keenly concerned with the establishment of such international cooperation in the exploration of outer space which would assure their participation in the solution of this all-human problem on an equitable basis and give them access to the practical results of space research. However, these countries soon discovered that there are two diametrically opposed approaches to international cooperation.

Two Approaches

The Soviet Union has always favored the pooling of the efforts of different countries in the peaceful exploration of outer space and expressed its readiness to use the achievements of space flight in the interests of the progress of other nations. It has emphasized that "outer space must be placed in the service of the cause of peace and the good of man, regardless of where he lives, in the east or west, in the south or north, in conditions of socialism or capitalism."

The Intercosmos program of joint space research of the Soviet Union and other socialist countries has provided scope for the rapid expansion of the activ-

ities of such Asian and Latin American countries as Vietnam, Mongolia, and Cuba, whose representatives have had the opportunity of participating in manned flight in Soviet vehicles. India is also one of the Soviet Union's "space" partners. The Intersputnik international communications organization set up by the Soviet Union and other socialist countries is open to anyone wishing to collaborate on equitable and mutually beneficial conditions. Specialists from developing countries are invited to seminars conducted for them in the USSR every two years, while every year 10 people receive scholarships at Soviet institutes of higher learning. The mutually beneficial program of cooperation between the USSR Academy of Sciences and corresponding organizations in a number of Asian, African, and Latin American countries on satellite geodesy has been operating for more than 10 years. It enables the developing countries to map unexplored areas relatively quickly and at low cost.

The other approach to cooperation with developing countries is typical of the imperialist powers, the United States in the first place. They are prepared to sell certain types of space hardware and offer different services, but they seek to turn such "cooperation" into yet another channel for increasing the technological dependence of Asian, African and Latin American countries on imperialism so as to gain political, economic and propaganda benefits. Their international space programs are inseparably linked with avaricious foreign policy goals.

When India asked the United States to help her in developing a satellite, the response was an offer to buy a ready-made one. Also indicative is the case of the Insat-A satellite, ordered by India and built and launched by the Americans in 1982. After functioning only several months instead of the planned seven years it went dead. The failure was painfully received in India. People spoke openly of the possibility of sabotage, of the American monopolies' unwillingness to relinquish their positions and allow new satellites in geocentric orbit. The Soviet Union helped India find a way out of this difficult situation. In the spring of 1982, the two countries signed an agreement under which a TV repeater on board the Soviet communications satellite Raduga began to operate for the Indian TV system.

Taking advantage of its scientific and technical superiority, the United States often sets its partners harsh conditions which they are forced to accept, for example, payment of all the costs of launching their satellites into orbit without any American guarantees of success. Remote earth exploration data from American satellites (mineral reserves in different parts of the world, harvest forecasts, etc.) are relayed first to Washington and only then can be forwarded to the governments concerned. The United States, moreover, is not averse to bringing pressure to bear on the other side, say by setting prices for agricultural produce in advance. The Americans are always mindful of their pocket. It was reported in the Indian press that in 1984 they requested triple payment for data supplied to India and started demanding exorbitant prices for photographs of the earth's surface.

Communication satellites are extensively used for ideologically reaching out to the people of developing countries. An example is experimental telecasts via an American satellite covering almost 30 countries. All programs began

with greetings from the US president and contained mainly advertisements of American space technology.

Problems and Prospects

In August 1982, the second United Nations conference on the peaceful use of outer space (UNISPACE-82) was held in Vienna. It devoted much attention to questions involving the developing countries. It was stressed that "space technology can in no way be regarded as a solution of the problems" of these countries, though it can become "an effective means of accelerating national development." The conference approved recommendations aimed at expanding the participation of Asian, African and Latin American countries in the exploration of outer space and facilitating access to its scientific and economic results.

The developing countries are justifiably concerned with the growing militarization of outer space sparked by the United States. It is becoming ever more apparent that the space spiral of the arms race launched by the US not only holds back the use of space technology for peaceful purposes but also threatens the very existence of mankind.

During the UNISPACE-82 deliberations these countries called for a ban on the testing, stationing and deployment of any weapons in outer space and called upon all countries to actively help prevent the spread of the arms race into that new sphere.

The Soviet initiatives aimed at preventing an arms race in outer space meet with broad support of the developing countries. Thus, at the 39th session of the UN General Assembly 150 nations supported the resolution "On the Use of Outer Space Solely for Peaceful Purposes and the Benefit of Mankind," and only the United States abstained, finding itself in virtual total isolation.

However, judging by foreign press reports, some developing countries are themselves not averse to joining military activities in space. Thus, Pakistan is considering the possibility of orbiting a military communications and observation satellite. This is encouraged by the United States which, it is thought, intends to participate in the construction of a space communications station in Pakistan designed for tasks of a military nature.

The difficulties experienced by the developing countries in the exploration of outer space objectively move them towards all-round cooperation among themselves. After all, even the economically highly developed countries have set up international space cooperation agencies (Intercosmos in the socialist countries, the European Space Agency in Western Europe). So far, however, only the members of some regional organizations, such as the Arab League and the Association of Southeast Asian Nations, have taken any more or less significant steps towards space exploration (the Arabsat and Palapa communications satellites). Proposals were made to launch the Afrosat communications satellite for African countries and the Condor satellite for the Andean group, and to set up a Latin American remote earth exploration system. India declared at the UNISPACE-82 conference its readiness to help other developing countries in space exploration.

The opportunities for expanding cooperation between Asian, African and Latin American countries on a bilateral and regional basis have been far from exhausted. Exchanges of equipment, technical services and experts can be expanded and there are benefits in building up common stocks of the most expensive and frequently required spare parts for space hardware and in joint ownership and operation of equipment both on the ground and in space.

In the early 80s, some 100 places were already occupied in the geostationary orbit (to keep from interfering with one another communications satellites must be kept at well-defined distances among themselves). It is only natural that the developing countries are very concerned with having places for their satellites in this orbit. Some equatorial countries, however, have been putting forward unjustified claims to sovereignty over segments of the geostationary orbit over their territories and are demanding that artificial earth satellites be stationed in those segments only with their explicit advance consent. Such demands contradict the norms of international law, which prohibit national claims to any portion of outer space and stipulate freedom of using it for all states. Some developing countries are also suggesting that certain frequencies be reserved for them since the wavebands suitable for communications via satellites are limited. Other as yet not fully resolved problems of international space law also cause concern among the developing nations, for example, how to prevent direct television and remote exploration of the earth from being exploited to the detriment of one state or another.

Such, in brief, are some of the "space" problems facing the developing countries. Able utilization of man's achievements in space exploration open up broad vistas to them, but it also requires major efforts both on the domestic level and in the international arena.

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SPACE POLICY AND ADMINISTRATION

HISTORICAL OVERVIEW OF INTERCOSMOS PROGRAM

Moscow ZEMLYA I VSELENNAYA in Russian No 6, Nov-Dec 84, pp 26-32

[Article by M. A. Rimsha under the rubric "Space": "Fifteen Years on the Tracks of Intercosmos"]

[Text] THE COOPERATION OF SOCIALIST COUNTRIES IN THE FIELDS OF RESEARCH AND THE USE OF SPACE FOR PEACEFUL PURPOSES IN ACCORDANCE WITH THE INTERCOSMOS PROGRAM IS A CLEAR EXAMPLE OF FRUITFUL, EQUITABLE AND MUTUALLY ADVANTAGEOUS SPACE COLLABORATION.

THE FIRST-BORN CHILDREN OF INTERCOSMOS

Fifteen years ago, on October 14, 1969, the artificial Earth satellite "Intercosmos-1" was launched from the Kapustin Yar Cosmodrome, initiating joint satellite research conducted by scientists and specialists from friendly countries (ZEMLYA I VSELENNAYA, 1976, No 3, p 28--Ed.). A little more than 2 years were spent on the preparations for this launch. The time period was quite small, considering that this was the first experience in joint space ventures.

The first envoys of the Intercosmos program were comparatively small space vehicles. They consisted of three basic sections: a cylindrical middle section and two hemispheres. The middle section of the satellites was set aside for the service systems necessary for the functioning of the craft itself and attached to it on the outside were the panels for the solar batteries. The storage batteries were placed in the lower hemisphere. The upper hemisphere served as the place for basing the satellites' scientific equipment: the sensoring section of the scientific equipment and the internal electronic units were placed on its exterior. The first craft of the Intercosmos series achieved orientation on the Sun with an accuracy of a few angular degrees. The builders of the satellite guaranteed its reliable working in space for a period of 2 months. The Intercosmos-1 scientific complex consisted of seven instruments (with a total mass of 31 kg.).

The launch of the Intercosmos-1 satellite initiated one of the basic directions of research conducted in accordance with the program of space cooperation by the socialist countries--research on the solar-terrestrial ties using satellites.

INTERCOSMOS-1 AND ITS "SOLAR" BROTHERS

Representatives of three nations--the Germna Democratic Republic, the Soviet Union and the Czechoslovak Socialist Republic--worked on the creation of the Intercosmos-1. Scientists and engineers from the GDR Academy of Sciences' Electronics Institute developed the Lyman-alpha photometer, which recorded the intensity of shortwave solar radiation found on the illuminated section of the orbit and determined the content of molecular oxygen in the Earth's atmosphere when the satellite entered our planet's shadow. In the CSR Academy of Sciences' Astronomy Institute, in collaboration with specialists from the Tesla Industrial Association, they created an x-ray photometer for routine observation and recording of the Sun's x-ray radiation during solar flares and also an optical photometer in order to study the change in the transparency of the upper atmosphere under the influence of high-altitude aerosol in the Earth's atmosphere.

The scientific coordination and management of the preparations, as well as the conducting of the scientific experiments on board the Intercosmos-1, was done by the collective of the USSR Academy of Sciences' Physics Institute imeni Lebedev, under the leadership of S. L. Mandelshtam, corresponding member of the USSR Academy of Sciences. This institute was represented within the satellite's scientific equipment complex by an x-ray spectroheliograph, a polarimeter and an antenna-feeder device for a special transmitter developed by GDR specialists. The transmitter "dumped" part of the scientific information obtained by the aboard instruments on ground receiving stations of the GDR, the USSR and the CSR. Thus, even on the first satellite launched in the Intercosmos program the problem of operational transmission of scientific information from aboard the satellite directly to the experiments' authors was solved. In subsequent years this idea was further developed and embodied in the sufficiently complex and highly informative telemetry systems.

The basic mass of scientific data, both from Intercosmos-1 and subsequent satellites of this series, was provided to the Earth by the standard telemetry systems of these same craft, the main task of which was guidance of the satellite during flight. These standard systems transmitted the scientific information to Soviet ground measuring stations. Subsequently this information was processed originally in the Soviet Union and then sent out to the countries participating in the experiments. The processing results were analyzed by all the participants in the research and then presented in the form of joint publications and reports.

FROM INTERCOSMOS-1 TO THE CONTEMPORARY METEOR

On 7 August 1981, the 22nd satellite of the Intercosmos series was placed in a near-Earth orbit and designated INTERCOSMOS-BULGARIA 1300 (ZEMLYA I VSELENNAYA 1982, No 6, p 4--Ed.). The complex scientific experiment regarding the study of the ionosphere and the magnetosphere was prepared and conducted by a collective of scientists and specialists from the Bulgarian Academy of Sciences' Central Space Research Laboratory, in close contact with their Soviet colleages, in commemoration of the 1,300th anniversary of the founding of Bulgaria.

How greatly the scope of research has changed in 12 years! On board the Intercosmos-Bulgaria 1300 satellite there were 12 scientific instruments, which were divided into 4 mutually complementary complexes based on their tasks. The weight of these instruments exceeded the "entire scientific payload" of the Intercosmos-1 BY A FACTOR OF 5. The carrying out of such a large-scale operation was made possible by the use of the METEOR type craft, which had proved itself quite well in the Soviet national space program and which is a hermetic container with solar battery panels, which are deployed after orbit has been established. The scientific equipment in such satellites are located in the lower compartment of the container. The Meteor is oriented according to three axes relative to the Earth's surface and its guaranteed period of operation in space is 1 year.

A distinguishing feature of the most recent experiment on the Meteor in accordance with the Intercosmos program was its complexity. In it measurements of various parameters of the ionosphere and the magnetosphere over a wide range were conducted. The investigations carried out by the individual instruments mutually complemented one another and enabled the acquisition of a detailed picture of the processes taking place in near-Earth space.

It became possible to accomplish all this only on the basis of the substantially increased level of space instrument making in the countries participating in the Intercosmos program.

IONOSPHERIC RESEARCH ON THE INTERCOSMOS SATELLITES

Intercosmos-2 belonged to the same family of "little ones" as its predecessor. Only in accordance with the fixed scientific task--the investigation of the Earth's ionosphere--was the orientation of the scientific instruments on the satellite accomplished using solar sensors and a tricomponent magnetometer, whose power was supplied by chemical batteries. The rejection of the use of solar batteries was caused by the necessity of holding disturbances of the medium in the satellite's flight path to a minimum.

The Bulgarian scientists and specialists began their own active work in the Intercosmos program with this very satellite. They have been maintaining their own devotion to aeronomic research for 15 years now, participating in experiments on the INTERCOSMOS-8 (1972), -12 (1974), -14 and -19 (1979) satellites.

For these ionospheric and magnetospheric satellites a variety of scientific equipment was also created by representatives from the GDR Academy of Sciences' Electronics Institute, the Hungarian Academy of Sciences' Physics Research Institute, the CSR Academy of Sciences' Geophysics and Astronomy institutes, the USSR Academy of Sciences' Space Research Institute and other Soviet scientific institutions. The research conducted on these satellites was complemented by the ground research of a network of ionospheric stations in Bulgaria, Hungary, the GDR, Cuba, Poland, Romania, the USSR and the CSR, which enabled the reception of a mass of new data on phenomena occuring in the ionosphere.

THE SCOPE OF RESEARCH EXPANDS

Over the past 15 years 22 satellites of the Intercosmos series have been launched. In the countries participating in the program of cooperation 68 types of instruments have been developed. The total number of instruments placed on the Intercosmos satellites is 141.

Equally impressive is the range of interests--the authors of the experiments have formed a number of permanently active international collectives. The already mentioned creative collaboration of specialists from the GDR, the USSR and the CSR produced good results at the time research was carried out on the INTERCOSMOS-1 (1970), -7 (1972), -11 (1974) and -16 (1976) satellites. To their credit they made the world's first recording of polarization of the Sun's short-wave radiation, a fact that has fundamental scientific value. The work on magnetospheric plasma carried out on the INTERCOSMOS-3 (1970), -5 (1971) and -13 (1975) satellites by researchers from the CSR Academy of Sciences' Geophysics Institute, Prague's Karlov University, the USSR Academy of Sciences' Institute for Terrestrial Magnetism, the Ionosphere and Radio Wave Propagation, the USSR Academy of Sciences' Space Research Institute and the Moscow State University's Nuclear Physics Scientific Research Institute has been given high marks. The group of scientists-authors of these experiments has been awarded a joint prize by the USSR and CSR academies of sciences.

THE FIRST CZECHOSLOVAKIAN SATELLITE

Participation in a large-scale experiment on the Intercosmos-18 satellite, launched in 1978, continued the creative union between scientists from the USSR and the CSR.

The experiment was significant due to the fact that, in the course of its preparation by Czechoslovakian engineers and technicians, the first Czechoslovakian satellite--the MAGION (ZEMLYA I VSELENNAYA 1980, No 1, p 44--Ed.)--was created. It was assigned to investigate the nature of the electromagnetic ties between the Earth's magnetosphere and the ionosphere. Placed into space on one launch vehicle, the satellites separted on command from the ground and in the course of 2 weeks conducted synchronous research in accordance with a coordinated program. By the end of the specified period the satellites had already worked through the individual programs.

INTERCOSMOS-6--A SATELLITE UNLIKE OTHERS

The magnitude of the Intercosmos satellite program requires various technical resources for its realization. In the experiment on the study of cosmic rays, prepared by scientists from Hungary, Mongolia, Poland, Romania, the USSR and the CSR in 1972, use was made of the INTERCOSMOS-6 spacecraft, which returned to the Earth. In it was placed scientific equipment weighing 1,070 kg., the basic part of which was made up of special photographic emulsion units. After a 4-day exposure in space the equipment returned to the Earth. The photographic emulsion units, with tracks of recorded charged particles, yielded an abundant amount of material for the specialists. In particular, on the photographic

emulsion there was an indication of a particle of energy of 10^{16} eV. Particles of such an order are impossible to obtain from any single accelerator currently at the scientists' disposal.

Until 1976, with the exception of the Intercosmos-6 satellite, experiments were conducted on the previously mentioned small-scale craft. They served the Intercosmos program excellently, "having worked" for 14 space watches.

A NEW GENERATION OF INTERCOSMOS SATELLITES

However, the development of space science and technology in the socialist countries and the constant expansion of the boundaries of scientific pursuit, as well as the improvement of the technical equipment for the conducted experiments, produced even higher requirements for the spacecraft used. This was clearly realized by the program's participants and, therefore, in 1976 a principly new craft was placed at the disposal of Intercosmos--the AUTOMATIC UNIVERSAL ORBITAL STATION (AUOS).

The exploitation of this satellite opened up a new stage in the space research of the socialist countries' specialists. An AUOS can take on board up to 120 kg. of scientific equipment and has a guaranteed period of active life of 6 months. The shape of the station is remniscent of a cylinder and to the upper section solar batteries are attached. The station's "eyes", that is, the places where the scientific equipment's sensors are based, are located on its bottom. Depending on the specified scientific task the station's longitudinal axis can be oriented on the Earth, the Sun or along the force lines of our planet's magnetic field. The station's telemetry system, capable of transmitting large streams of scientific information to Earth, has significantly expanded the possibilities for the experimenters.

In June of 1976, the first such station, designated INTERCOSMOS-15, passed its space exam (ZEMLYA I VSELENNAYA 1977, No 3, p 39--Ed.). This launching was experimental from many points of view. During it, in particular, flight tests were made of the unified international telemetry system (UITS), created by the engineers and technicians from Hungary, the GDR, Poland, the USSR and the CSR.

TECHNICAL EXPERIMENTS ON THE INTERCOSMOS SATELLITES

On the Intercosmos-1 satellite there was a special transmitter which dumped scientific information in a direct transmission mode to ground receiving stations in the GDR and the CSR. Seven years later a complete system had been prepared which, during a flight, was capable of storing and accumulating scientific information by means of on-board tape recorders and, on command from the ground, of transmitting it at high speed to special ground stations of the countries participating in conducting the experiments. Thanks to the UITS the scientists had the opportunity for direct contact with their own devices installed on the satellites. Operational efficiency and convenience in the reception of necessary information are the main merits of the UITS.

Two more AUOS type satellites--INTERCOSMOS-20 (1979) and -21 (1981) also solved technical problems, at the basis of which were tests of new service equipment, which had been created for scientific purposes. The authors of the UITS continued their own tasks, having created an equipment complex for research on our planet's surface--a system for collecting and transmitting information. In this system the satellites were given the role of collectors of a variety of information needed by oceanologists and volcanologists, as well as geologists, meteorologists, hydrologists and agricultural workers. These satellites interrogate data from special buoys, equipped with the necessary measuring and transmitting equipment and located at various, and at times hard-to-reach, places on Earth. The collected information is then transmitted by the satellite to central ground stations, which receive and effectively process the data.

Having passed the tests in 1976, the automatic universal orbital stations became the BASIC space facility of the Intercosmos program. In 1977 INTERCOSMOS-17 (ZEMLYA I VSELENNAYA 1978, No 3, p 48--Ed.), an AUOS type scientific satellite, was placed in orbit and was intended for research on cosmic radiation. Behind it followed new automatic universal orbital stations: INTERCOSMOS-18 and -19 (ZEMLYA I VSELENNAYA 1980, No 1, p 44--Ed.).

THE FRUITFUL UNION OF SOVIET AND POLISH SCIENTISTS

Of course it is necessary to note also the joint work of specialists from the USSR Academy of Sciences' Radiophysics and Electronics Institute and the Torun Observatory (Poland) on the INTERCOSMOS-COPERNICUS 500 satellite (ZEMLYA I VSELENNAYA 1976, No 3, p 28--Ed.). The work was conducted on the ninth satellite in this series in 1973, when the whole world observed the 500th anniversary of the birth of the great Polish scientist, Nikolas Copernicus. The experiment on research on the Sun's sporadic radio-frequency radiation produced valuable scientific results. The high marks given to this work resulted in a joint award for the authors of the experiment from the USSR and Polish academies of sciences.

THE INTERCOSMOS PROGRAM AS IT RELATES TO OUR SOVIET SPACE RESEARCH

When talking about the satellite research program being carried out within the framework of cooperation between the socialist countries, it must be noted that many scientific instruments were also created in the socialist countries for the Soviet national space program. Beginning in 1976, such equipment has been installed on all the high-apogee PROGNOZ satellites. At the same time it is a pleasure to note that the x-ray photometer created by the CSR Academy of Sciences' Astronomy Institute has proved itself excellently and has become standard equipment for similar type craft.

The Bulgarian equipment installed on the METEOR-PRIRODA satellite launched in 1981 was also distinguished by its high quality.

THE PROSPECTS FOR THE INTERCOSMOS PROGRAM

As before, the AUOS type satellites, which have undergone many tests, are in the

researchers' arsenal. With their help plans have been made for carrying out active experiments in research on the near-Earth plasma. An experiment on the Prognoz stations will be devoted to the study of shock waves. Small, second generation Czechoslovakian satellites, younger brothers of MAGION are also supposed to participate in these experiments.

For many joint experiments craft with which the participants are well acquainted will be used, However, the research proposed to be carried out on them has a completely new quality, if it can be thus expressed, "a modern sound."

Many joint tasks have been completed on the Prognoz satellites. Several of them have produced very valuable scientific results. At the present time scientists from a number of socialist countries are making preparations for a complex experiment using four satellites at the same time--two Prognoz satellites and two SEPARABLE SUBSATELLITES of Czechoslovakian manufacture, which, over the course of a significant period of time, will begin to carry out research according to a specified scientific program on the auroral tail area of the Earth's magnetosphere.

For this complex study of the ionosphere and the magnetosphere systems, equipment with a total weight of more than half a ton, making up a unified scientific system, will be placed on these satelllites. Included in the system's make-up are on-board computers which will enable it to conduct complex guidance experiments. The authors of the project are planning on carrying out measurements of a full set of parameters for the plasma, for active particles and for the electromagnetic fields in the auroral area, with simultaneous monitoring of the activity of the magnetosphere's tail. The presence of several satellites will permit measurements at various times and in various places of the parameters of the plasma and of the magnetic fields.

Principly new tasks confront the space physicists who are preparing complex research on the plasma processes using AUOS type stations. Something new for the Intercosmos program is the active method of conducting these experiments. Using special electron and plasma guns installed on the station they will cause disturbances of the plasma. Recording and analyzing the processes created by these disturbances will call for complex units of scientific equipment where use of microprocessor technology will be suitably employed.

Large streams of scientific information will be transmitted to Earth using a modernized version of the Unified Telemetry System, the carrying capacity of which will significantly exceed the capacity of its predecessors. In these projects a visible role is being assigned as well to the Czechoslovakian subsatellites--they will have a substantial "growth" in weight, as well as in dimensions, in comparison to the first Magion. The vernier engines developed especially for them enable the satellites to effect complex maneuvers in space.

In recent times the activity of planetary researchers has significantly intensified. Whereas earlier space physicists working on the Intercosmos program occupied themselves more with near-Earth space, now their scientific interests

are turning more and more frequently to "beyond the limits of terrestrial attraction."

The conducting of experiments in the field of planetary research requires the development of complex instruments and whole sets of scientific equipment using the contemporary achievements of science and technology. Specialists from Bulgaria, Hungary and the CSR have made a large contribution to the preparations for one of the most complex projects of modern times--"VENUS--HALLEY." Moreover, in the socialist countries equipment is being developed as well for the Soviet AUTOMATIC INTERPLANETARY STATIONS.

The steadily growing potential of space science and technology in the socialist countries is the entire basis for believing that the tasks set in the field of space research in accordance with the Intercosmos program will be successfully resolved.

PHOTO CAPTIONS

1. p 26. The Intercosmos-1 satellite. Equipment installed on it was prepared in the GDR, the USSR and the CSR.

2. p 27. This is how the Intercosmos-Bulgaria 1300 satellite looked.

3. p 29. The "first-born" Czechoslovak space satellite--the Magion.

4. p 30. This is how the Intercosmos-15 automatic universal orbital station (AUOS) looked.

5. p 31. The Intercosmos-Copernicus 500 satellite.

6. p 32. The high-apogee Prognoz satellite.

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SPACE POLICY AND ADMINISTRATION

IN MEMORY OF IOSIF SHKLOVSKIY

Moscow ZEMLYA I VSELENNAYA in Russian No 4, Jul-Aug 85 pp 44-46

[Obituary signed by "Group of comrades" in "People of Science" section]

[Text] On 3 March 1985, after a grave illness, the death occurred of Professor Iosif Samuilovich Shklovskiy, an outstanding Soviet astrophysicist, Lenin Prize Laureate, corresponding member of the USSR Academy of Sciences. One of the founders of modern continuum astronomy, a great scientist and fine man has passed away.

I. S. Shklovskiy was born 1 July 1916 in the town of Glukhov, Sumy Oblast. After finishing seven-year school in 1931, he worked as a team leader and foreman at the construction of the Baikal-Amur Railroad. In 1933, Shklovskiy enrolled in the physics and mathematics department of the Vladivostok University, transferring two years later to the physics department of Moscow State University. In 1938, the young optical physicist was accepted as a graduate student at the astrophysics department of the State Astronomical Institute imeni Shternberg, where he studied under Docent N. N. Pariyskiy. Thus, without the benefit of a special education, began the career in astrophysics of I. S. Shklovskiy, a scientist whose contributions to the establishment of modern astrophysics is immeasurable. It is hard to name any topical branch of 20th-century astronomy in which I. S. Shklovskiy has not left a significant, if not fundamental, mark.

Iosif Samuilovich's early work was devoted to solar physics. His high-temperature solar corona theory explained all the observed data accumulated by the 1940s and gave impetus to further research. He made a major contribution to explaining the energizing mechanisms for radio and X-ray emissions of the sun. Almost forty years later, Shklovskiy's series of "solar" work has lost none of its significance and continues to be a reliable basis for studying solar physics.

Shklovskiy's investigations of cosmic radio emission won him widespread recognition. He voiced a number of ideas which determined the development of radio astronomy during its early stages. Shklovskiy developed a method of spectral separation of the thermal and nonthermal components of the radio emission of the Galaxy which made it possible to identify bright galactic radio sources. Shklovskiy also demonstrated the possibility of observing the neutral hydrogen

line on the 21 cm wavelength. Extensive search for the line was successful. This marked the beginning of systematic and effective investigation of the structure of our and other galaxies. Iosif Samuilovich was the first to investigate the possibility of observing radio lines of interstellar molecules, notably hydroxyl molecules. This work led to the discovery of cosmic masers and associated processes of star formation and to systematic observations of radio emissions of complex molecules in interstellar space.

Iosif Shklovskiy explained the optical luminescence of the Crab Nebula in the framework of a synchrotron emission mechanism hypothesis. His work in connection with investigation of the Crab Nebula vividly demonstrated his ability to bring together scattered experimental data, use them to formulate a coordinated theory, and go back to experiments, offering clearcut recommendations for further observations. It was that approach that led to the origination of continuum astronomy.

I. S. Shklovskiy made a great contribution to the development of the theory of evolution of supernova remnants which provided the basis for the prediction and subsequent discovery of X-ray emission. The models of supernova remnants proposed by him explained many specific features of their emissions, notably the ratios between X-ray, optical and radio emissions. He also demonstrated that neutron stars formed as a result of supernova outbursts and have acceleration. This may explain the high velocities of pulsars and makes it possible to predict the existence of an extended halo of old neutron star populations.

Shklovskiy carried out a number of pioneering works in the theory of stellar evolution. In the latter 50s he proposed an evolutionary sequence for stars of moderate mass after leaving the main sequence: red giant--planetary nebula--white dwarf. This hypothesis contributed to the emergence of contemporary views on stellar evolution and was subsequently expanded in the work of both Soviet and foreign astrophysicists.

I. S. Shklovskiy devoted much attention to studies of extragalactic objects. He was one of the first to analyze observations of the radio galaxies Fornax A, Cygnus A, and Centaurus A, and he postulated that the optical emission of the burst from the nucleus of galaxy M87 is of synchrotron nature, which was subsequently irrefutably confirmed by observations.

Immediately after the discovery of quasars in 1963, Shklovskiy suggested looking for the optical variable 3S273 on old plates, and such a variable was found. In 1965 he put forward the idea of the unified nature of quasar and galactic nucleus activity. For 20 years now this approach has made it possible to draw ever new important conclusions regarding the physics of processes in active nuclei of galaxies and quasars.

More recently I. S. Shklovskiy devoted much attention to problems of X-ray and gamma-ray astronomy. He enthusiastically discussed new results in those rapidly developing fields of astrophysics, putting forth original and bold hypotheses to explain various unusual phenomena, such as X-ray bursters, gamma bursts, discrete gamma sources, and objects of the type SS433. Iosif Samuilovich showed great interest in new data obtained in the infrared region,

especially with the help of space vehicles, as well as in the latest achievements in constructing models of the universe and in modern cosmological theories (it was Shklovskiy who coined the term "relic emission"). A man of excellent memory and remarkable intuition, he managed to keep track of new information in virtually all rapidly developing fields of astrophysics, and he reacted keenly to it. Shklovskiy invariably capped his theoretical work with conclusions that could be verified by direct observation. That is why Shklovskiy the theoretician enjoyed such tremendous prestige among experimental astrophysicists the world over.

Iosif Samuilovich also made a weighty contribution to the organization and development of new schools in radio astronomy and extra-atmospheric astronomy in the Soviet Union. The department of radio astronomy he set up in 1953 at the State Astronomical Institute imeni Shternberg was one of the first in our country. This department, which Iosif Samuilovich headed till the last days of his life, played and continues to play an important part in the establishment of many new trends in astrophysics. The first Soviet astrophysical experiments in space vehicles were begun and successfully conducted under his supervision. In 1969, I. S. Shklovskiy organized and headed the astrophysics department at the USSR Academy of Sciences' Institute of Space Research.

In 1960, I. S. Shklovskiy was awarded the Lenin Prize, and in 1966 he was elected corresponding member of the Academy of Sciences. He was member of the International Astronautical Federation, the London Royal Astronomical Society, the American Academy of Science and Arts, the American National Academy of Science, and the Astronomical Society of Canada. Shklovskiy was presented the highest astronomical award, the Bryussovskaya Gold Medal of the Pacific Ocean Astronomical Society.

I. S. Shklovskiy established the school of modern continuum astronomy. His pupils are working in all our country's leading astronomical institutes, and they include two corresponding members of the Academy of Sciences, ten doctors and more than thirty candidates of science.

Shklovskiy made important contributions to the philosophical interpretation of the latest achievements of contemporary science (including astrophysics), as well as to the understanding of man's place in the cosmos and his role in transforming the surrounding world. He set forth some of his ideas on these problems in several papers and in his fine book, "The Universe, Life, Intelligence," which won a vast reading public, from school children to scientists.

Shklovskiy's remarkable talent as a popularizer of science, his original thinking, temperament of a brilliant orator, and numerous lectures before a vast audience on the most topical problems of astrophysics made him extremely popular among both scientific circles and all people interested in astronomy.

For many years I. S. Shklovskiy headed the astrophysics seminars sponsored by the Academy of Sciences' Institute of Space Research for associates of research establishments of Moscow and other cities of the country and eminent foreign scholars. He initiated the scientific readings devoted to the memory of the outstanding Soviet astrophysicist, Professor S. B. Pikel'ner, which have been conducted since 1976.

Iosif Samuilovich was an interesting person, a witty interlocutor, a fine narrator and a man of outstanding literary and artistic talent. Every popular science article of his which appeared in NAUKA I VSELENNAYA invariably drew the attention of readers, evoking numerous responses and high praise. His well-intentioned, though occasionally caustic, criticism attracted people to a much greater degree than it antagonized them. Everyone who had the good fortune of associating with that remarkable person and vivid, interesting personality invariably fell under the spell of his charm.

The pupils and colleagues of Iosif Samuilovich Shklovskiy will forever retain his bright image in their memory, while the brilliant scientific ideas of that outstanding scholar will illumine the way for many generations of astrophysicists.

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LAUNCH TABLE

LIST OF RECENT SOVIET SPACE LAUNCHES

Moscow TASS in English or Russian various dates

[Summary]

Date	Designation	Orbital Parameters			
		Apogee	Perigee	Period	Inclination
9 Nov 85	Cosmos-1701	39,342 km	613 km	11 hrs 49 min	62.8°
13 Nov 85	Cosmos-1702	399 km	207 km	90.2 min	72.8°
15 Nov 85	Raduga	36,655 km	--	24 hrs 41 min	1.3°
		(Communications satellite for telephone, telegraph and radio communications and transmission of television programs; near-stationary, circular orbit)			
23 Nov 85	Cosmos-1703	678 km	647 km	97.8 min	82.5°
28 Nov 85	Cosmos-1704	1,023 km	986 km	105 min	82.9°
3 Dec 85	Cosmos-1705	387 km	208 km	90.1 min	72.8°
11 Dec 85	Cosmos-1706	360 km	178 km	89.5 min	67.2°
12 Dec 85	Cosmos-1707	678 km	650 km	97.8 min	82.5°
13 Dec 85	Cosmos-1708	313 km	197 km	89.2 min	82.3°
		(Data is transmitted to the State Scientific-Research and Production Center "Priroda" for processing and use)			
19 Dec 85	Cosmos-1709	1,026 km	982 km	104.9 min	82.9°

Date	Designation	Orbital Parameters			
		Apogee	Perigee	Period	Inclination
24 Dec 85	Molniya-3	40,793 km	477 km	12 hrs 16 min	62.8°
		(Communications satellite for long-distance telephone, telegraph and radio communication and for transmission of USSR Central Television programs to the "Orbita" network)			
25 Dec 85	Cosmos-1710, -1711, -1712	19,160 km	--	11 hrs 17 min	65°
		(3 satellites launched by single launch vehicle; to test elements of a space navigation system for location of USSR commercial aircraft and vessels of merchant marine and fishing fleets; near-circular orbit)			
26 Dec 85	Meteor-2	975 km	952 km	104 min	82.5°
		(Meteorological satellite; carries equipment to take pictures of cloud cover and underlying surface in visible and IR bands both in memory and direct transmission modes and equipment for monitoring penetrating radiation in near-earth space; data goes to the State Research Center for Study of Natural Resources and USSR Hydromet Center for processing and use)			
27 Dec 85	Cosmos-1713	419 km	224 km	90.7 min	62.8°
28 Dec 85	Cosmos-1714	863 km	190 km	94.8 min	71°

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END