

Villen Lyustiberg

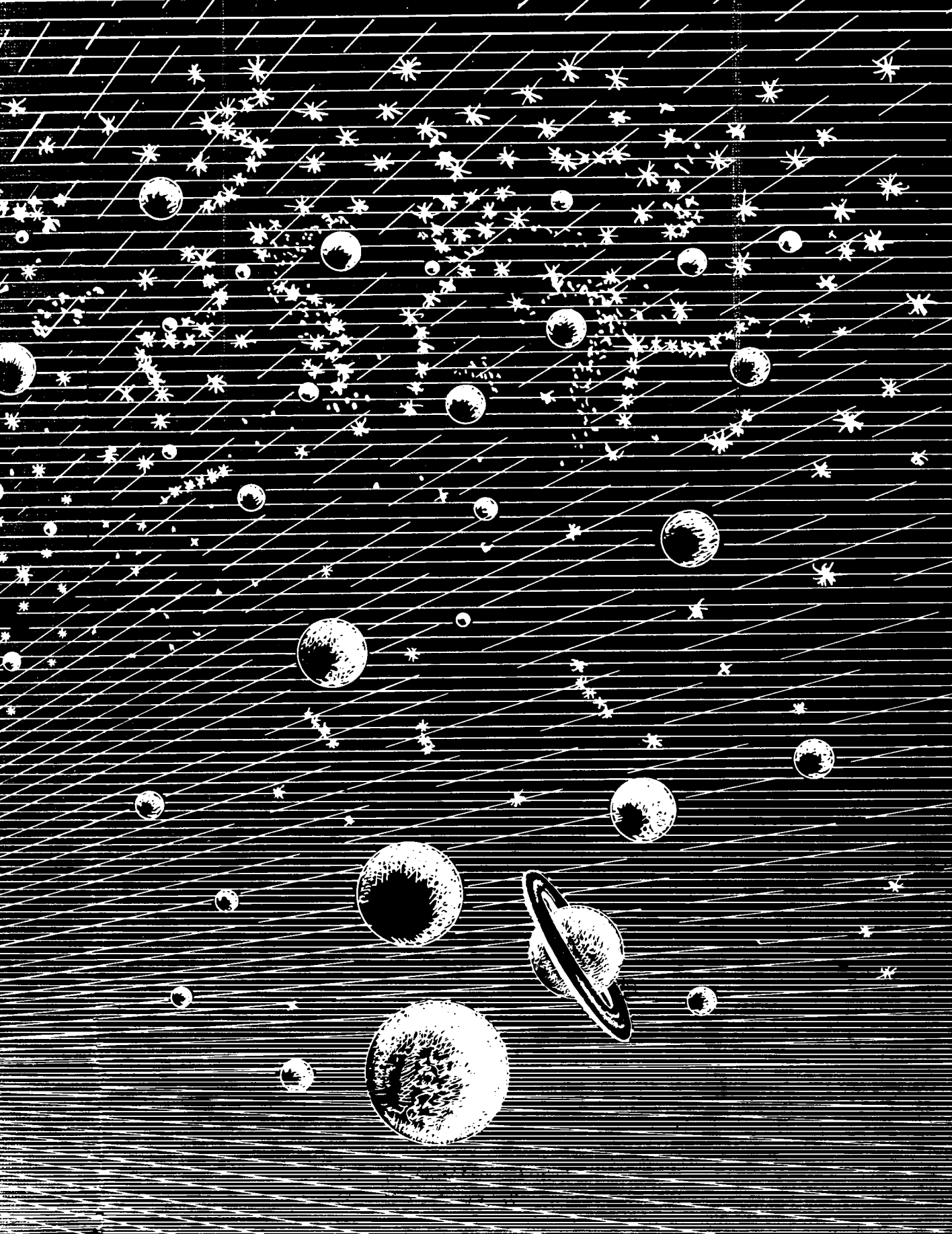


Man and Space

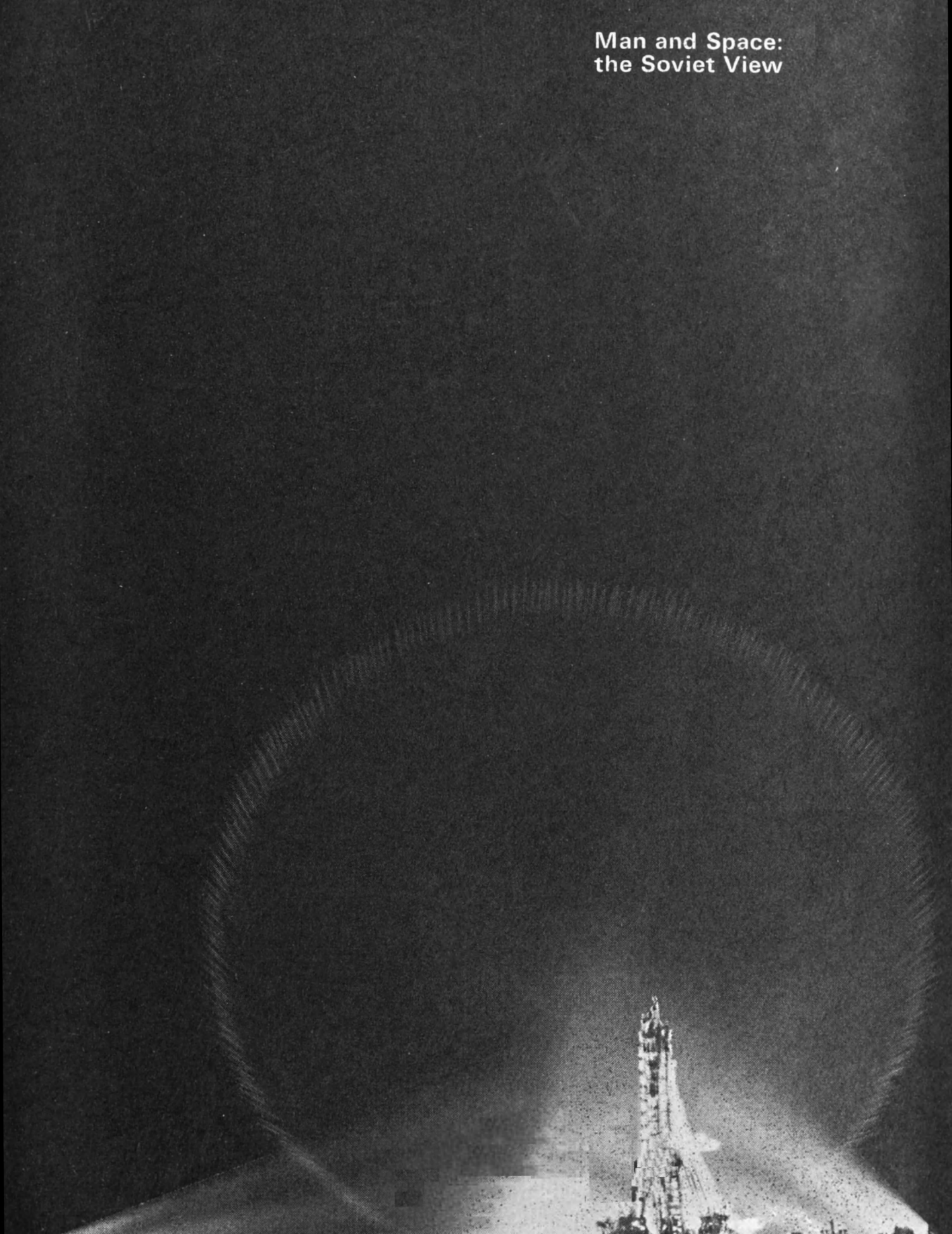
the Soviet View

by Yuri Maximov





**Man and Space:
the Soviet View**



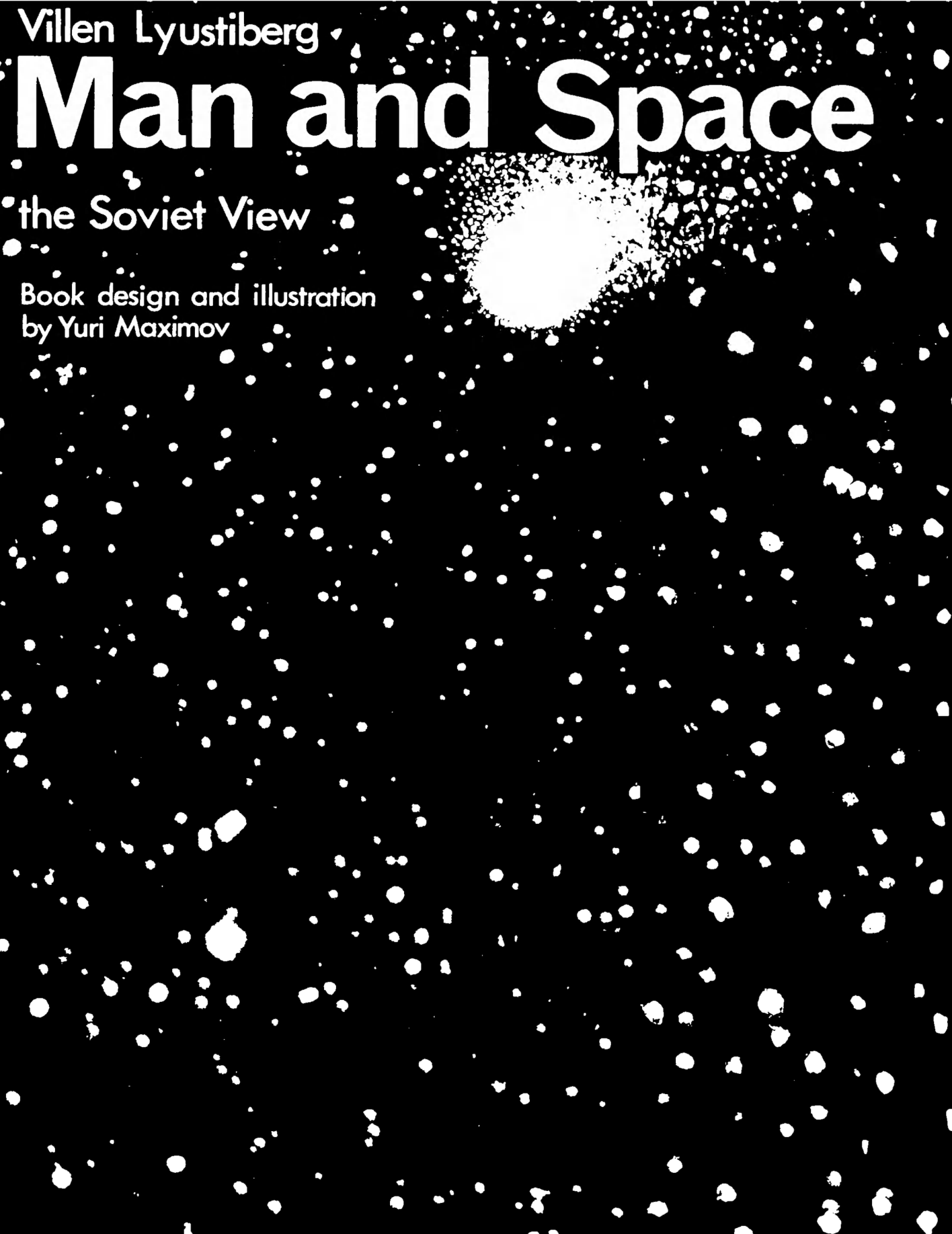


Villem Lyustiberg

Man and Space

the Soviet View

Book design and illustration
by Yuri Maximov



Man has a certain vanity, a desire for distinction. He meticulously records his achievements in the annals of history. But he has not always been able to recognise those that deserve to be called great.

Is this not why our remote ancestors left no clue as to who was the inventor of the wheel, who conceived the idea of sowing grain, who wrote the first word . . . ?

Today, from a distance of thousands of years, we know that these were momentous, truly great discoveries, even if they were dictated by prosaic necessity, by the needs of daily life.

The commencement of the space era represents the greatest achievement of all of the human intelligence—as has already been acknowledged, for alongside all other resounding and deserving appellations to describe the twentieth century, the “space age” quickly and firmly established itself as the most fitting term for the epoch in which we live.

But why did it become the “space” age? What sort of necessity is it that prompts man to reach out towards other worlds? And indeed, is there any such need? This is not just a rhetorical question. Different people give different answers to it.

We hear expressions such as “the military rivalry of the superpowers”, or “the battle for prestige”.

Even the eminent British historian, Arnold Toynbee, felt compelled to offer this criticism some years ago:

“In a sense going to the moon is like building the pyramids or Louis XIV’s palace at Versailles. It’s rather scandalous, when human beings are going short of necessities, to do this. If we’re clever enough to reach the moon, don’t we feel rather foolish in our mismanagement of human affairs?”

In other words, exploration of the cosmos is to all intents and purposes immoral, a wasteful extravagance.

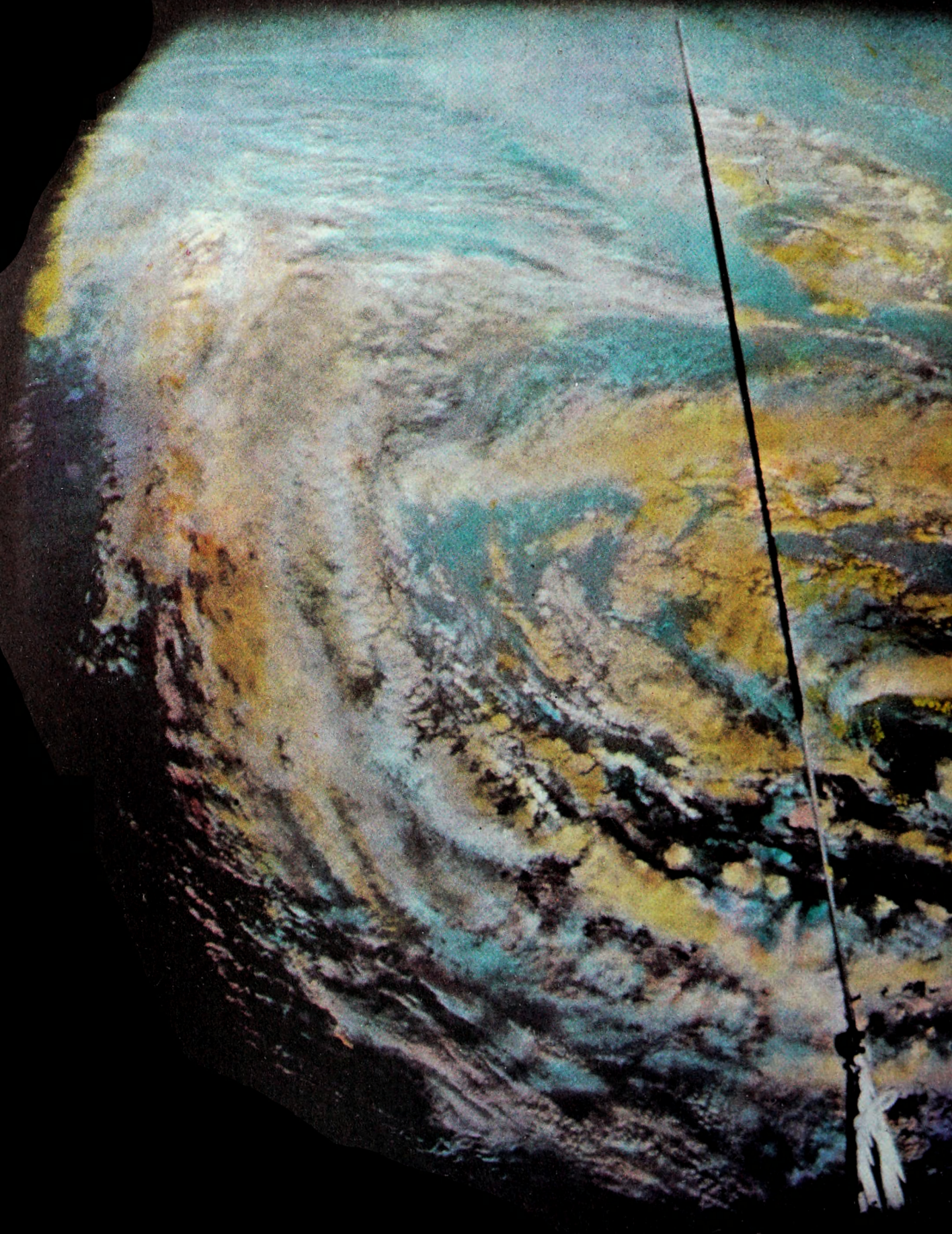
Such a point of view might seem to have some justification, but it is by no means shared by everyone. We may reply to it by quoting the Soviet writer, Chingiz Aitmatov:

“Of course, the money spent on space research might be put to other use. But in my opinion human society has certain problems of a higher order, which, if left unsolved, would make it difficult to achieve progress.”

This point of view is clearly shared, too, by Soviet Academician Leonid Sedov:

“At the present time, in many countries the expenditure on scientific research is growing appreciably, but even so it is only a fraction of the amounts allocated for some other purposes in the non-productive sphere—the military, for example.”

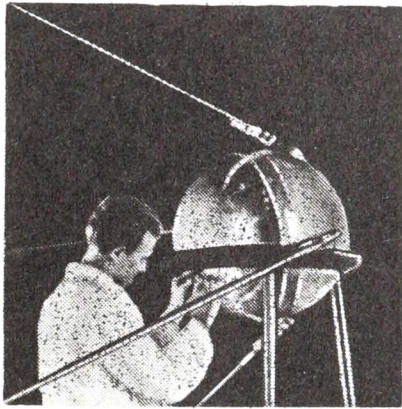
In this booklet we shall examine the Soviet space programme. Is space research motivated by a desire to win national prestige, or is the rapid advance of the present-day scientific and technological revolution inescapably drawing mankind to look beyond the earth's confining atmosphere? What tangible benefits do we, people living today, receive from space flights? Have the discoveries made in space changed our views, our feelings, our thinking? Let us ponder these questions dispassionately for the reader to draw his own conclusions . . .



**Chapter I voicing
disagreement with the
view that because there
are so many unresolved
problems on earth,
the cosmos can wait**



A Review of Events



THE BEGINNING OF THE SPACE AGE

The launching by the USSR of the world's first artificial satellite, on 4 October, 1957. The sputnik, equipped with a radio transmitter, weighed 83.6 kg. The "break-through" came about as a result of the Soviet Union's achievements in the fields of rocket technology, electronics, automatic control, computer technology, cosmic mechanics and a number of other branches of science. The man-made satellite transmitted a large volume of valuable information on the shape and parameters of our planet, on the physical characteristics of inner space, and on radiowave propagation. All this information was needed for the calculations and planning of further, more complicated space flights.

We are used to sensations. But on the 4th of October, 1957, when a Soviet sputnik weighing 83 kg made the world's first orbital flight, optical goods shops in Europe and America quickly sold out binoculars and even opera glasses. People rushed to buy them in the hope of being able to see with their own eyes the tiny shooting star—a new heavenly body made by man himself.



Galileo's telescope in the 17th century gave man his first deep look into Space. With the first artificial satellite man began to probe it with instruments. Many scientific works and popular books have been written about the significance of this event.

And then on 12 April, 1961, the world was again agog with the news of Yuri Gagarin's 108-minute flight in space—an exploit which opened before mankind the prospect of interplanetary travel. In Moscow, Leningrad and other cities people poured out into the streets to see the hero. Verses were written and songs composed in his honour, and his television picture was featured in the newspapers of all countries. The President of the United States, the late J. F. Kennedy, told Congress that America had to make good the damage to its prestige and also embark upon a space programme, grand in its conception.

Nineteen years later, in 1980, when Leonid Popov and Valery Ryumin accomplished their record-breaking 185-day flight, this

The world press called Yuri Gagarin a "citizen of the Universe". The first cosmonaut travelled all over the world and everywhere people wanted to shake hands with him as here in Copenhagen.

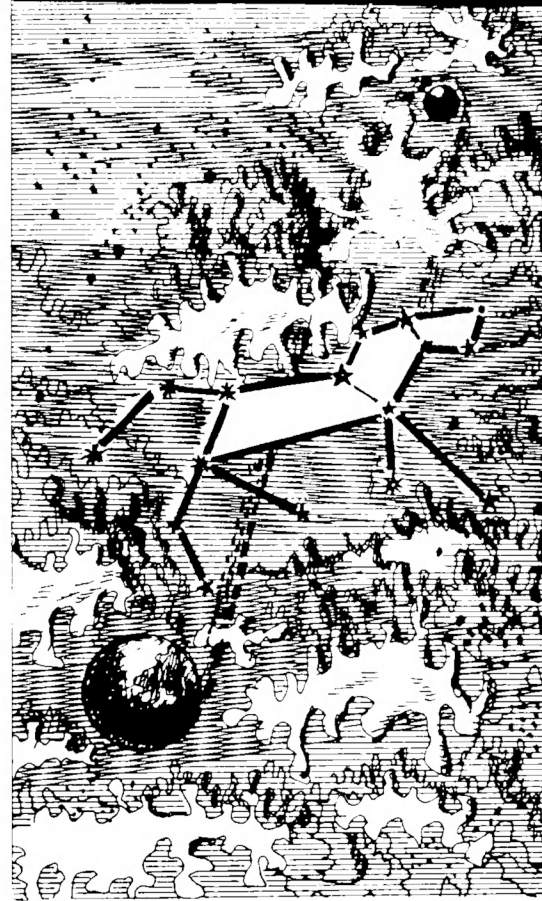


A Review of Hypotheses



was regarded as a routine mission, certainly an important and interesting one, but all the same a more or less ordinary "work assignment" representing just another stage in the exploration of the universe.

We have been living for nearly twenty-five years already in the "space age". In these years the Soviet Union's *Luna* stations have delivered samples of moon-rock to the earth, the *Lunokhod* automatic mobile laboratories made a thorough investigation of the surface of our natural satellite, and probes sent to Mars and Venus have transmitted valuable information and pictures of the surface of the distant planets. Many of the achievements of Soviet space scientists are "firsts" for the world. But this, of course, is not



Cosmonauts Yuri Romanenko (left) and Georgi Grechko spent 96 days on board the Salyut-6 orbital station in 1978. Their endurance record was broken by...

Vladimir Kovalyonok (right) and Alexander Ivanchenkov. They spent 140 days in space in the same station.



HWANG TI

The "son of heaven", in Chinese mythology, who is said to have descended to earth in the Hwang Ho river basin about 2600 B.C. Ancient texts say that he commanded a variety of strange, complicated conveyances, and had about eighty assistants—four-eyed, six-armed robots, that fed on rocks and sand.

After living among people for 100 or 300 years (the sources give different times), Hwang Ti returned to his celestial home, 78 light-years distant from the earth, somewhere in the constellation of the Lion.

A Review of Events



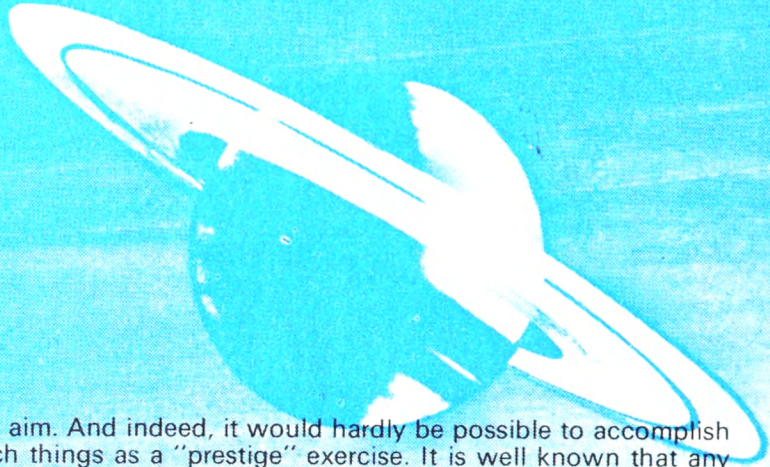
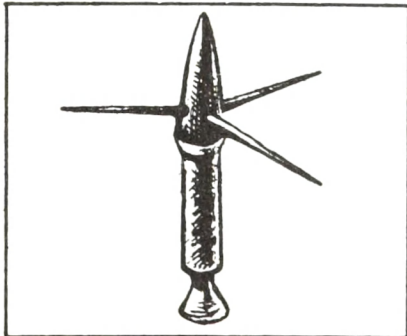
A DOG CALLED LAIKA

The first living creature to fly in space in a near-earth orbit. It was launched aboard the second sputnik (508 kg) on 3 November, 1957, in a container equipped with a life-supporting system.

The flight confirmed that earth-based organisms could exist for some time, at least, in space.

EXPLORER-1

The first American artificial satellite of the earth, launched into orbit on 1 February, 1958. It weighed 8.3 kg and had a diameter of 15 cm.



the aim. And indeed, it would hardly be possible to accomplish such things as a "prestige" exercise. It is well known that any major technical advance is achieved only when it has been well prepared for by the development of a nation's science in its entirety.

It would seem that at the present stage, when astrophysicists are trying to establish the cause of the "Great Red Spot" on Jupiter, and the origin of the craters on Mercury, and when telecameras on interstellar voyager craft have sent back totally unexpected pictures of the rings around Saturn, which, it is claimed, upset the "laws of celestial mechanics", it is rather late in the day and doesn't make sense to renew the debate as to whether there is any "need" for space research. And yet the argument continues. The opposing viewpoints can probably be broadly described today as follows. On the one hand, it is asserted that man is an earth-creature, and that his future will always be with the planet that gave him birth. This "anti-space" conservatism reflects a stereotyped way of thinking and is steeped in the past, in the long history of human society.

The other point of view, forward-looking, predicts that modern civilisation will launch out into other worlds. This was the belief of the founder of cosmonautics, the Russian scientist, Konstantin Tsiolkovsky (1857-1935). In his well-known work, "Rocket Flying Machines", he wrote:

"Mankind will not remain for ever on the earth, but, in a quest for light and space, will, at first timidly, penetrate the atmosphere, and later conquer the whole of the solar system."

Tsiolkovsky believed that the earth, which had given birth to mankind, was like a cradle, and that sooner or later man would begin to feel that it was confining him. This point of view, regrettably, is sometimes distorted in the West, where people prominent in the scientific field have depicted the cosmos only as offering a future "way out" for mankind, an escape from the consequences of man's inability to solve the ecological problems associated with intensive industrialisation. They prophesy that the time will come when man will abandon for ever his polluted, dried-up, mutilated planet, and advance this notion to excuse a care-free attitude to the rapacious plundering of the earth's resources.

Thus, there are two diametrically opposed standpoints: on the one hand, the impossibility in principle of man ever leaving his planet, and on the other—the inevitability of his doing so.

But the moment the argument is presented in this manner we query the necessity for adopting such extreme positions. As often happens, could not the calm and sensible truth of the matter lie somewhere in between?

"Many of us who have flown in space," said the Soviet cosmonaut, Alexei Leonov, "have had the thought: how much land there still is on our planet waiting to be worked! I am sure that, given the effort, every free part of the surface could be made fertile and productive. If that were done there would hardly then be any shortage of food in the world, and there would at the same time be an abundance of oxygen."

Boris Raushenbakh, Corresponding Member of the USSR Academy of Sciences and a well-known specialist in the field of space exploration technology, says: "In all history I think it can be said that the sceptics have more often than not been proved wrong. And scepticism in the technical field is the unsoundest position of all to adopt when considering the distant future. Speaking truthfully, therefore, I must say that I don't know and cannot see at the present time how man could set out in the next few centuries to colonize other worlds in space, but I believe that this will come to pass."

But not all Soviet scientists agree with this view. Academician Mikhail Styrikovich, in a reference to future energy sources, expressed a different viewpoint: "To utilise solar energy it is not at all necessary to move off to somewhere else in the cosmos. All that is necessary is to have large power stations in high orbit with the means to convert and transmit the energy to earth. Man won't

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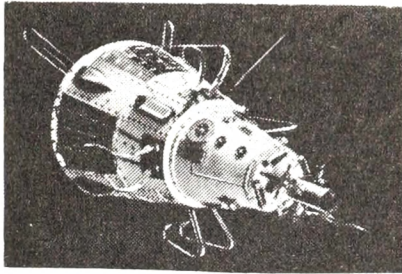
DOGU

Statuettes of "pre-history cosmonauts", clad in "space-suits", who supposedly visited Japan in neolithic times, three or four thousand years ago.

However, experts consider that these small figurines are characteristic of the ceramic art of the Ainu, the ancient tribe which inhabited the islands of Japan. All the known statuettes of this kind depict women, a circumstance which is considered to indicate the existence of a matriarchal society at that time, and the details of the costumes are more in keeping with richly ornamented clothing than with any kind of "space-suit".



A Review of Events

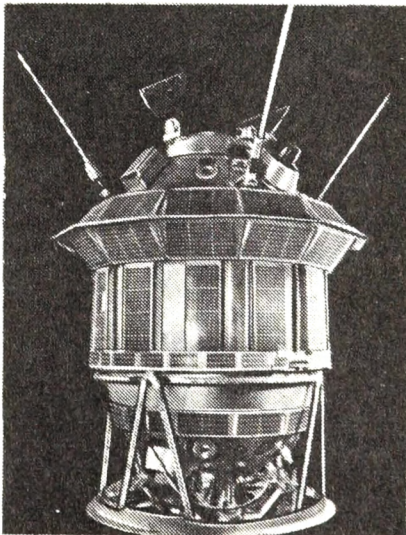


THE FIRST SPACE LABORATORY

The third Soviet artificial satellite (launched on 15 May, 1958) With its scientific equipment it weighed, 1,327 kg, and it continued transmitting information until 6 April, 1960. The data received enabled scientists to determine the pressure and composition of the upper layers of the atmosphere and the concentration of charged particles, and to study cosmic-ray radiation, magnetic and electrical fields, the frequency of collisions with micrometeorites, and many other phenomena.

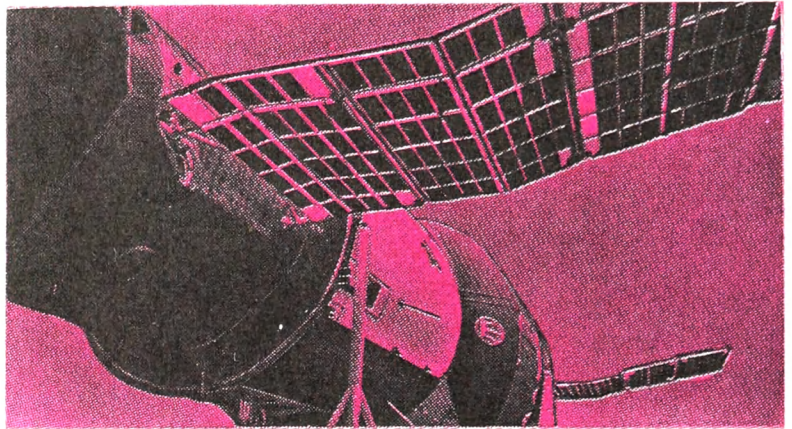
LUNA-3

The Soviet automatic station which, for the first time,



ever have to resettle in some other part of space—there simply won't be any need for that."

Assessing the place of space programmes in world scientific, technological and social development at the present stage, it would seem obvious that the best course is that of an optimal



A duplicate of the Salyut-6 orbital station with its life-supporting systems and its solar battery wings extended at the Gagarin cosmonauts training centre.

combination of the earth-bound and space-oriented trends, making use of the possibilities opened up by space research for the benefit of people living now, and for those who will live in the future, on the planet earth.

For those who measure progress only by the amount of visible material benefits, for whom money is a commodity useful only for purchasing yet another car or pleasure craft—for such people means spent on acquiring knowledge, on satisfying that prime mover of progress since time immemorial, man's rewarding curiosity—the means devoted to space research will always be money just thrown away. If, in the past, man had been motivated only by utilitarian considerations, governed purely by expediency, Columbus would no doubt have preferred to grow oranges and grapes instead of exploring the unknown Atlantic, and Newton, instead of pondering over the laws which caused the famous apple of the story to be drawn from the tree to the ground, would in all probability have simply eaten it.

The study and exploration by man of the universe—and this is a point of view which Soviet scientists have in common—does not at all mean that he is incapable of facing up to earthly problems, that he is running away from them. It represents a qualitatively new, and often the sole means of solving many scientific and technical questions of the greatest importance. Every series of space flights provides us with new, necessary information, adding to our knowledge. One of the most recent examples of this is the work carried on for four years now on board the *Salyut-6* manned orbital station by successive crews.

The series of flights to the *Salyut-6* station, which is equipped with two docking units, began with an unsuccessful attempt to dock by the crew of *Soyuz-25* in October, 1977. But on 11 December, Yuri Romanenko and Georgi Grechko, aboard *Soyuz-*

26, accomplished the operation using one of the docking modules. A few days later, when they had adapted to the conditions of weightlessness, they left the station, clad in space suits, and carried out an examination in open space of the other docking module.



Soviet cosmonauts Leonid Popov and Valery Ryumin. On April 9, 1980, they went up aboard Soyuz-35 and docked it with the Salyut-6 orbital station. They spent 185 days working aboard the station. On his two space missions in 1979 and 1980 Valery Ryumin stayed in orbit for a total of 360 days.

Just one month later, on 11 January, 1978, *Soyuz-27*, manned by Vladimir Dzhanibekov and Oleg Makarov, also docked with *Salyut-6*. For the first time, the orbital station had two spaceships docked with it. The crew of *Soyuz-27* brought to the two men working at the station new instruments, supplies of film, and parcels and letters from home.

This flight represented an important technical advance. Professor Konstantin Feoktistov, himself a cosmonaut, commented on it as follows:

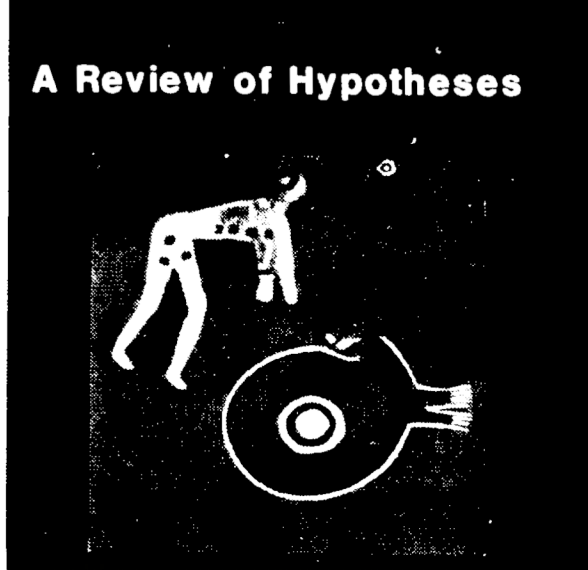
"We were convinced of the practicability of using the station with interchangeable crews and of delivering fresh stores and additional equipment. However, to dock with a composite object already formed of two linked craft had not been done before, and some of us were apprehensive about the possibility of encountering a whip-lash effect, that is, that stresses might be set up which could result in a fracture at the place where the two already linked craft were joined together."

But the calculations of the design engineers proved sound, all was well, and after spending five days on the station Dzhanibekov and Makarov returned to earth in *Soyuz-26*, leaving behind their own craft for the long-term residents, Romanenko and Grechko.

A week later, on 22 January, an automatic cargo craft, *Progress-1*, was launched into orbit and docked with the scientific complex comprising *Salyut-6* and *Soyuz-27*. In external appearance *Progress* is similar to the *Soyuz* spaceships, but actually it constitutes a new type of spacecraft. It had a launch weight of seven tons and carried a 1,300-kg cargo (including supplies of water) and about a ton of fuel components and compressed gas.

In the course of the orbital manned flight of the *Salyut* research complex, air is expended, some being lost each time use is made of the air-lock chamber, including when the cosmonauts leave the station to conduct work in open space. Fuel is used up too, and also substances which absorb carbon dioxide. And there are

A Review of Hypotheses



TASSILI FRESCOES

The rock drawings discovered by the French archaeologist, Henri Lotte, in the Tassili Mountains in the Sahara. There has been some conjecture (supported, in particular, by sensation-seekers) that the drawings by ancient African artists are portrayals of cosmonauts and the spaceships in which they visited the earth at some time.

Africa specialists are more inclined to think that these drawings have a religious significance, and depict some ritual observance, the meaning of which has long since been lost.

A Review of Events

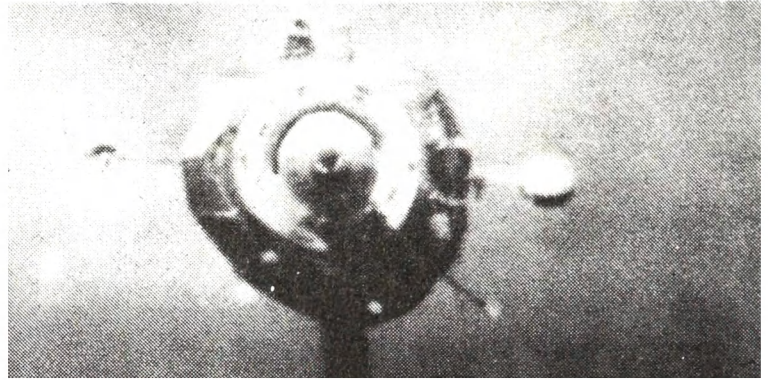


photographed the mysterious far side of the moon, never before seen by man. Launched on 4 October, 1959, it carried out the photographic assignment on 7 October and transmitted the pictures back to earth from a distance of nearly half a million kilometres.

The craters and "seas" on the hidden side of the moon, mapped for the first time, were given the names of Giordano Bruno, Frédéric Joliot-Curie, Jules Verne, Igor Kurchatov, Nikolai Lobachevsky, Mikhail Lomonosov, Thomas Edison, Konstantin Tsiolkovsky, and other prominent scientists.

items of scientific equipment that require replenishment. The Progress cargo-craft was designed specifically to deliver these necessary materials to the research station.

Progress-1 remained docked with the manned complex for fifteen days. During this time Romanenko and Grechko transfer-



Millions saw this fantastic picture on TV: the Progress automatic transport ship locates and approaches the Salyut-6 station to dock gently with it.

red the cargo to the station and successfully carried out the refuelling operation. On 6 February, after the cargo-craft had been emptied of its useful contents and loaded with containers carrying waste from the station, its engines were used to push *Salyut-6* into a new orbit. *Progress-1* then undocked, transferred to automatic regime, and upon a command from earth its braking engines were switched on, bringing it down into the dense layers of the atmosphere where it burned up over the empty expanses of the Pacific ocean.

On 3 March, 1978, in *Soyuz-28*, the world's first international crew manned by Alexei Gubarev (USSR) and Vladimir Remek (Czechoslovakia) arrived at the station. Long before this flight, in 1967, scientists of the socialist countries agreed upon a programme of cooperation in space research called *Intercosmos*. This sets out the main direction of joint work in space—work that has already produced significant results.

Under the *Intercosmos* programme the scale of cooperation is constantly increasing, more ambitious projects are being undertaken and more complex experiments are being carried out.

Further flights by international crews were also envisaged under the joint programme. The next flight in this series (27 June-5 July, 1978) was accomplished by Miroslaw Hermaszewski of the People's Republic of Poland and Pyotr Klimuk (USSR), the commander of *Soyuz-30*. This was followed (26 August-3 September, 1978) by a third orbital mission, the crew this time being Valery Bykovsky (USSR) and Sigmund Jähn (cosmonaut-researcher of the German Democratic Republic).

In April 1979 *Soyuz-33* was launched with Nikolai Rukavishnikov (USSR) and Georgi Ivanov (Bulgaria) on board. However, because of engine trouble, docking with the station was impossible, the mission was terminated and the cosmonauts returned to Earth.



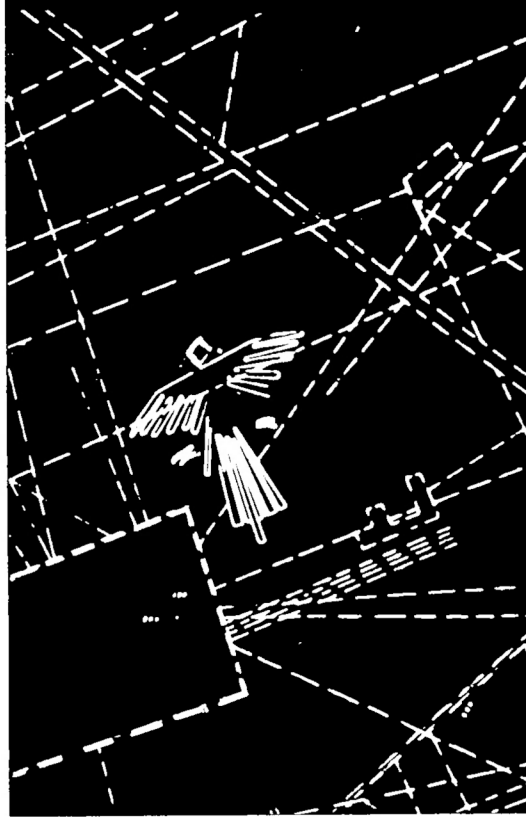
The first mixed-crew missions began in spring 1978. The Salyut-6 orbital station was visited by six space research crews, including: Czechoslovak cosmonaut Vladimir Remek (front) and Alexei Gubarev (USSR); Polish cosmonaut Mirosław Hermaszewski (left) and Pyotr Klimuk (USSR); Sigmund Jähn of the German Democratic Republic (right) and Valery Bykovsky (USSR).

As was mentioned earlier, in 1980 cosmonauts Leonid Popov and Valery Ryumin worked aboard *Salyut-6* for what was a record period of time—185 days (from 9 April to 11 October). The year before, from February to August, Valery Ryumin had already spent 175 days in orbit together with Vladimir Lyakhov . . .



The Intercosmos emblem.

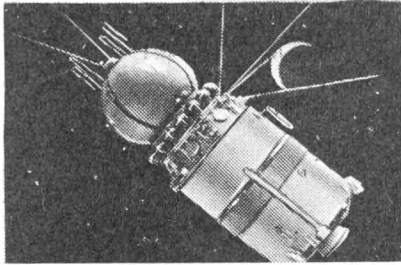
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NASCA DESERT MARKINGS

The puzzling, enormously large drawings in Peru of birds and animals and of a series of spirals and straight lines reminiscent of the runway markings of a modern airport. Executed by the ancient Incas many centuries ago, the outsize drawings can be viewed only from the air. It has been claimed that they are "signal markings" for flying guidance made by visitors from other planets. But a well-known researcher of the mysterious drawings, West German archaeologist Maria Reich, considers that, for the Incas of the time, they had a precise astronomical significance, indicating the correct time for the planting and sowing of crops, etc.

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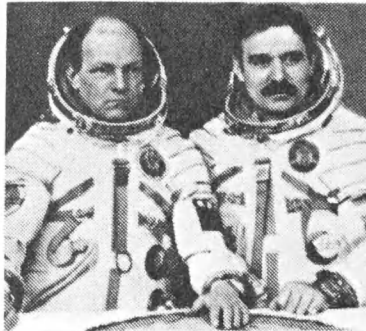
VOSTOK

The spacecraft which carried the first man into the void beyond the earth's atmosphere. At 09:07 hrs, Moscow time, 12 April, 1961, Yuri Gagarin took off and circled the earth for one hour and 48 minutes, demonstrating that man could fly in near-earth space, more than 300 km above the earth, at a speed of nearly 28,000 km per hour, and still preserve his ability to work normally.

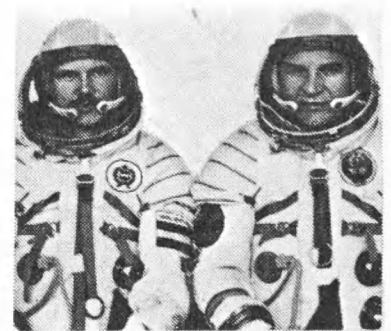
By international agreement, the 12th of April is celebrated each year as Cosmonautics Day.



During their mission Popov and Ryumin played host to three international crews: Valery Kubasov (USSR) and Bertalan Farkas (Hungary) in May 1980, Viktor Gorbatko (USSR) and Pham Tuan (Socialist Republic of Vietnam) in July, and Yuri Romanenko (USSR) and Arnaldo Tomayo Mendez (Cuba) in September.



Cosmonauts Nikolai Rukavishnikov (USSR) and Georgi Ivanov (Bulgaria). They flew aboard Soyuz-33 in April 1979. However, some trouble with the attitude-control engine made docking with the Salyut-6 orbital station impossible. The mission was terminated and Soyuz-33 returned to Earth.



Cosmonauts Valery Kubasov (USSR) and Bertalan Farkas (Hungary). Flying together, they visited the Salyut-6 station in May 1980.

On 11 June, 1980, leaders of the National Centre for Space Research in France introduced to pressmen two French pilots—Jean-Loup Chrétien and Patrick Baudry who had been selected for a future Soviet-French space mission.

Each country makes its own contribution to the agreed research programme. For instance, instruments made by specialists of the Czechoslovak Academy of Sciences were installed on practically all satellites of the *Intercosmos* series and geophysical rockets of the *Vertikal* series. Polish specialists were responsible for preparing a series of experiments to study the ionosphere and magnetosphere of the earth. Using equipment designed by specialists of the USSR and Poland, a programme of research was carried out by the satellite *Intercosmos Copernicus-500*, launched to honour the quincentenary of the birth of the great Polish astronomer. For photographing the earth's surface in different bands of the spectrum, a special multispectral camera, the MKF-6M, was developed by Soviet and GDR engineers. At the time that Romanenko and Grechko were operating it, a group of specialists from the German Democratic Republic, headed by Professor Hans Fischer, director of the Institute of Electronics, was at the space control centre.

"Our institute", said the professor, in talking to correspondents, "has made on-board instruments for space research beginning with the very first satellite of the *Intercosmos* series. Working

together, the socialist countries can utilise to the fullest extent the new possibilities opened up by space research for science and their national economies."

The flights by international crews are a graphic result of this joint work.

Man is constantly in search of new horizons. Having invented machines by means of which he is able to leave the ground and fly above the clouds, he seeks to rise even higher. Already he has overcome the seemingly insuperable force of gravity binding him to the earth, and it is inevitable that he will strive to go further, to penetrate the depths of the universe.

But this is only one aspect of the exploration of space. There is another, no less important.



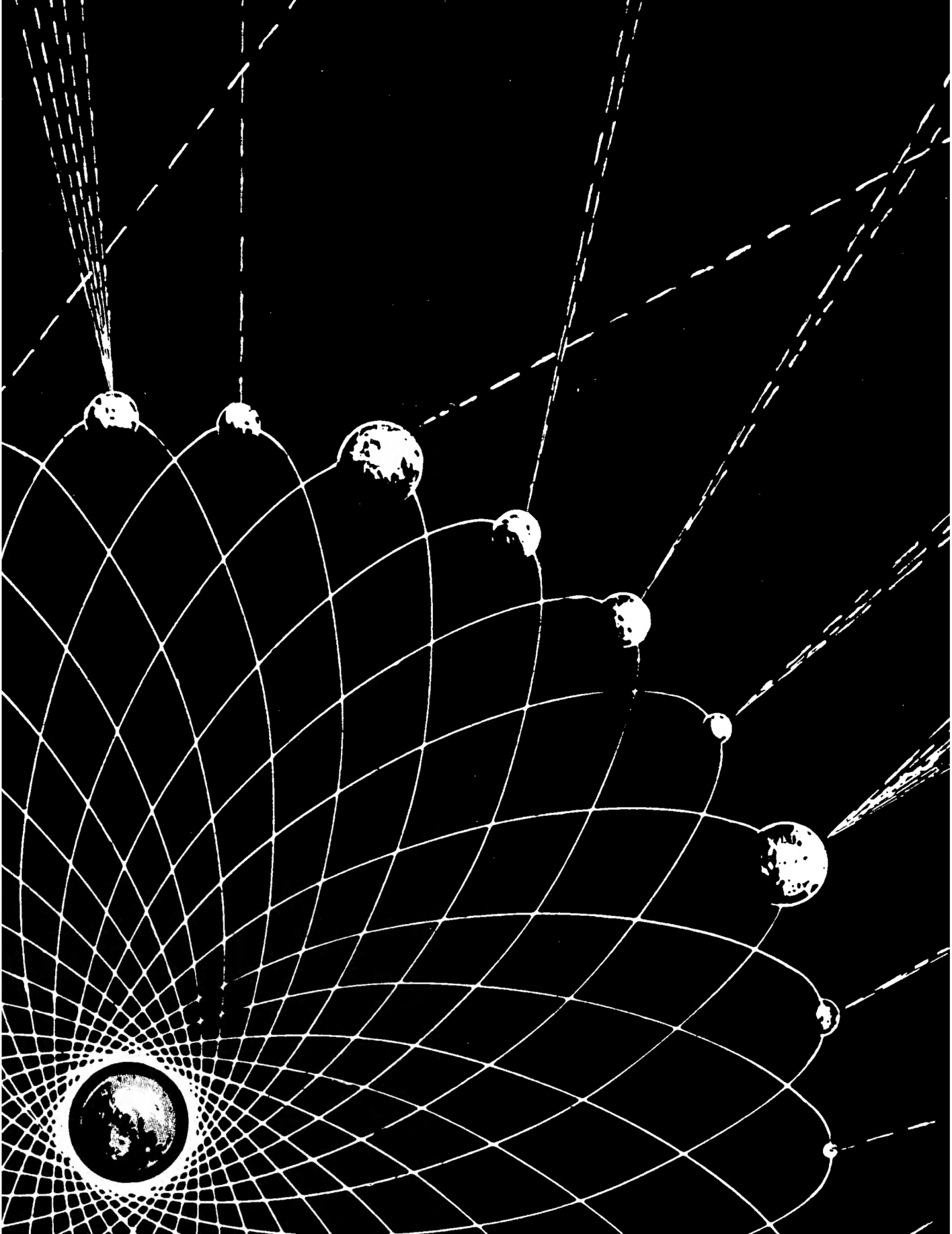
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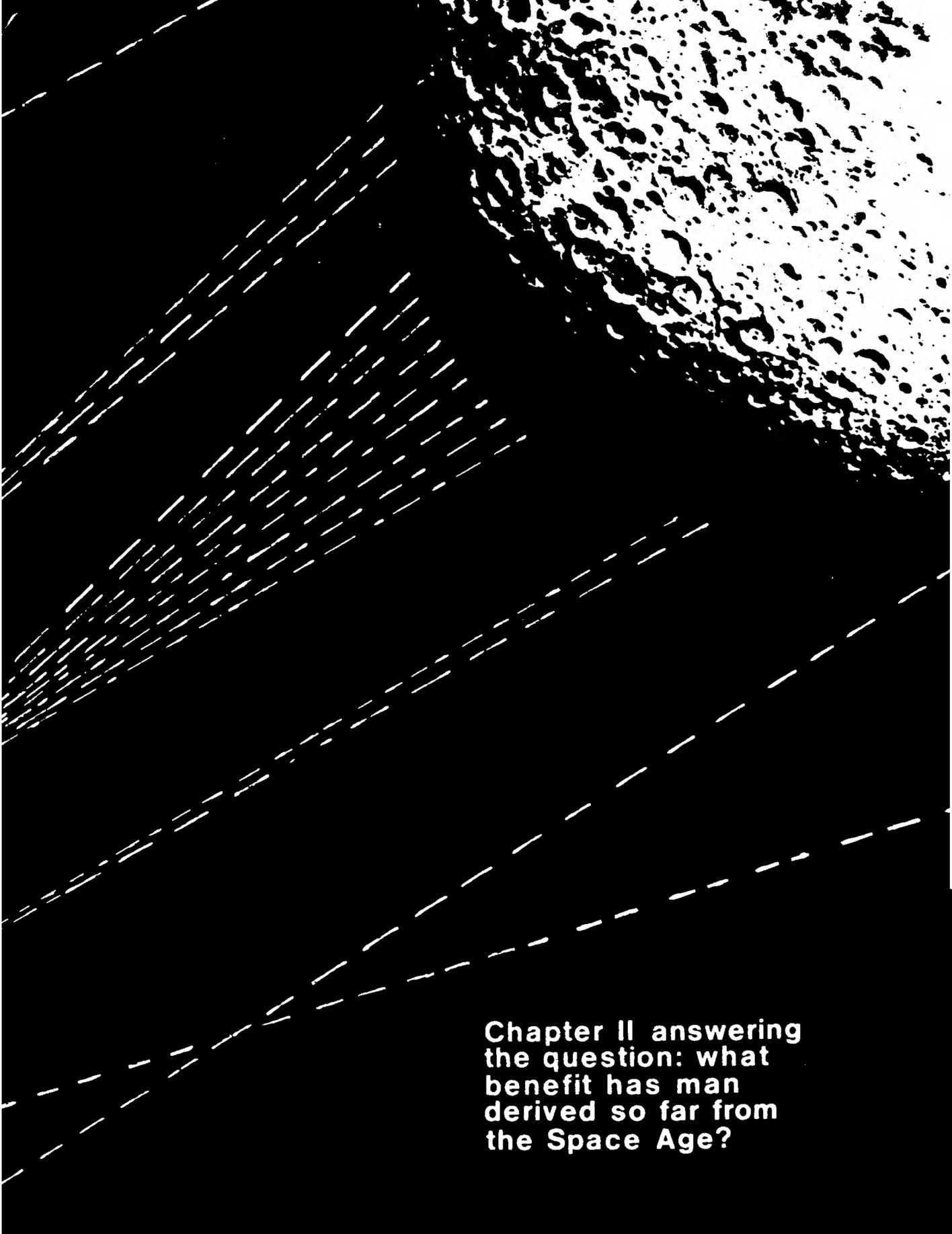


MAYA CALENDAR

The calendar used by the Mayas (who had a highly developed civilisation) before the discovery of America by Columbus. The calendar is very accurate, and some scientists find it hard to accept that the Mayas could have possessed sufficient knowledge for its compilation. It begins in the year 3373 B.C.

The Mayas established that once every 104 years the sun, moon and Venus appear in the same position relative to one another. Attributing to the number 104 a sacred meaning, the Mayas organised a grand religious celebration every 52 years. There is a theory that they received the calendar from "strangers from the starworld", who, it is claimed, visit the earth approximately every 650 years.





**Chapter II answering
the question: what
benefit has man
derived so far from
the Space Age?**

A Review of Events



VOSTOK-6

The craft which carried the first (and so far only) woman cosmonaut, Valentina Tereshkova, in an orbital space flight of three days' duration (16-19 June, 1963). This exploit had its beginnings in the old Russian town of Yaroslavl, when Valentina joined a local aero-club and took up parachute jumping as a sport.

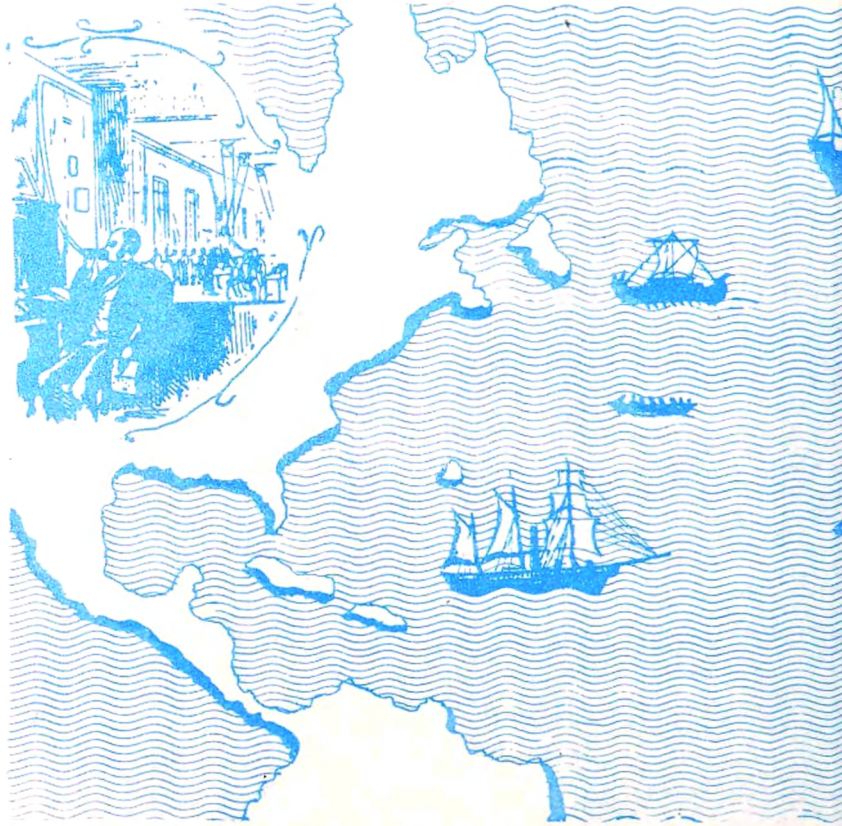
In *Vostok-6* she circled the globe for 71 hours, making 48 revolutions and covering a distance of about 2,000,000 kilometres.

Her husband, Andrian Nikolayev, who is also a cosmonaut, has made two space flights—in *Vostok-3* in 1962 and *Soyuz-9* (with Vitaly Sevastyanov) in June, 1970.

Today Valentina Nikolayeva-Tereshkova is President of the Soviet Women's Committee.

... It was right on 4 o'clock when the phone rang.
"You have a call in for New York?"
"Yes."
"Go ahead, please!"

We were ringing our friends, who had been posted to the USA in an official capacity, knowing that today they would be having a



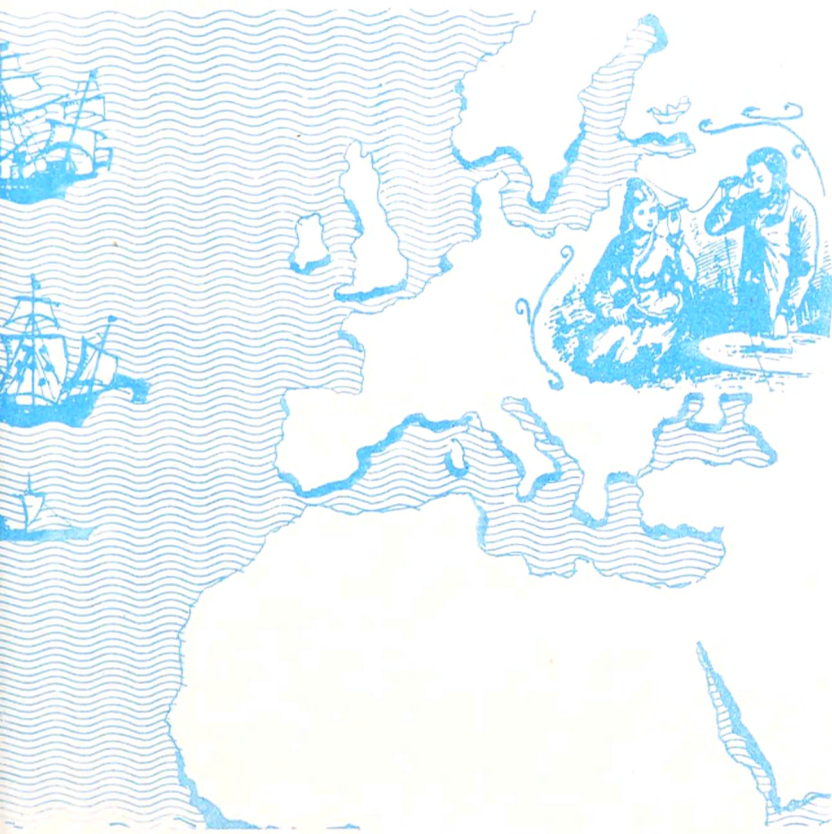
family celebration. Immediately after the congratulations they exclaimed in surprise: "What a marvellously clear connection! It sounds as if you are just next door. . ."

It was a long-distance call via satellite. And we are well accustomed to television relays, not only from any part of the globe, but even from other planets. All this we take for granted, so much so that sometimes there is ironical comment, as shown by the following extract taken from the March, 1970 issue of *The UNESCO Courier*, and written by an American writer and engineer, Gene Gregory:

"The casting of the *Apollo 11* and *12* voyages on millions of television sets around the world gave it the character of a sports event. Focus was on the astronaut champions of a new inter-planetary Olympiad, and on the faultless performance of the spacecraft. In the process, the real significance of space exploration became obscure."

This is perhaps a rather uncompromising view to take, but the author raises just the point we wish to stress: for many years we have been reaping the benefits of applied space technology, and we have simply not given thought to the fact that this new technology—such as having the services of satellites available in our own home—derives precisely from space research.

By the middle of the last century two isolated systems of communication had formed in the world—one in Europe and the other in America. Each of them conveyed "local" news by telegraph line to the population they served. But it took weeks for important news to arrive by ship from the Old World to the New. And although it was clear that establishing a transatlantic link



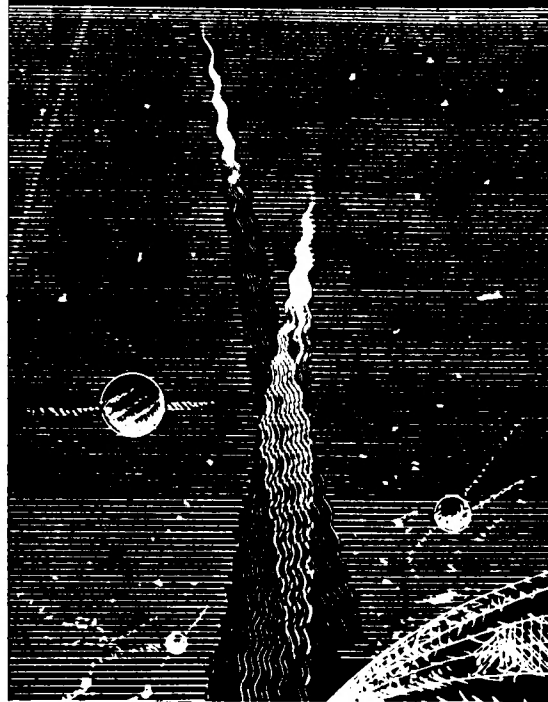
was only a matter of time, it took a tremendous amount of labour and effort on the part of a host of scientists, design engineers, inventors and sailors before a reliable cable was laid in the summer of 1866, linking Europe and America.

This was a telegraph link ("only a telegraph link"—we would say today). Ninety years later, in 1956, just a few months before the launching by the Soviet Union of the world's first artificial satellite, a 38-channel transatlantic telephone cable, the first of a kind, was put into operation. It connected Oban in Scotland with Clarenville in Newfoundland.

On the face of it there would seem to have been no special need for it: radio, embracing the world, had long been established already, and a radio-telephone communication link across the Atlantic had been in operation since 1927.

But there was the question of reliability. Radio communication is notoriously sensitive to electrical interference—whether from storms or from industrially produced electrical noise and to the state of the ionosphere (the Heaviside layer which reflects radio frequencies, thus making it possible to transmit radio signals around the globe). This part of the ionosphere is affected by solar activity, and its efficiency for radio purposes varies according to

A Review of Hypotheses



"WORLDS IN COLLISION"

Book by an American writer, Immanuel Velikovsky, first published in 1950.

On the basis of ancient mythology and legend the author advances the hypothesis that catastrophes suffered by the earth, as recounted in many myths, were a consequence of cosmic cataclysms.

According to Velikovsky's theory, several thousand years ago a piece of the planet Jupiter flew off and formed a gigantic comet which began to drift about the solar system, approaching the earth from time to time and terrifying its inhabitants. About 1500 B.C. the comet brushed close to the earth in passing, one of the consequences of which was the Exodus of the Jews from Egypt and their crossing of the Red Sea, the waters of which "parted" because for about half an hour the earth's rotation was halted.

Later, the comet returned several more times to the earth, flooding it with oily showers and other kinds of substances (the "manna from heaven"). Finally, the comet collided with Mars, its tail being torn off in the process, and turned into the planet Venus.

For the time being the situation in our corner of the universe is calm. But this does not mean, the author maintains, that there will be no further cosmic upheavals. They will inevitably recur, and mankind will again be confronted with disasters of unimaginable magnitude.

A Review of Events

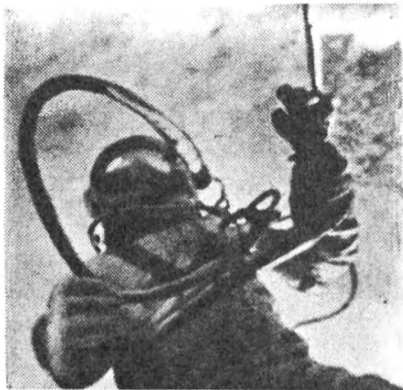


VOSKHOD

Spacecraft, weighing, 5,320 kg, designed for a crew of three, and having a system for soft landing. On 12-13 October, 1964, it accomplished a flight of 24 hours 17 minutes, manned by Vladimir Komarov, the commander, Konstantin Feoktistov, space researcher, and Boris Yegorov, space doctor. The flight programme included testing of the flying characteristics of the craft and of the life-supporting system for the larger, three-man cabin, as well as medical and other scientific investigations.

"WALK IN SPACE"

Man's first "step" in open space, protected only by a space-suit.

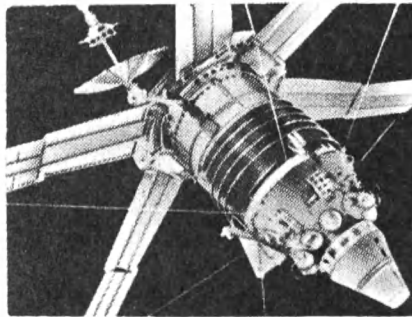


the time of year and time of day. Sometimes radio contact is lost, the voice fading out, and there is no telling when it will be re-established.

Clarity of speech transmission and the fact that it is not affected by atmospheric interference are the great advantages of the cable system. So, despite the high cost of this system it is still in use today.

The situation has changed, however, with the introduction of UHF multi-channel satellite transmissions. A characteristic of transmissions in the ultra-high frequency wave band is the almost complete absence of interference. Moreover, they can be used not only for telephone communication but also for TV programmes.

Communications satellites act as the required mirror to reflect radio-frequency signals, and are not influenced by solar disturbances. They also cover a wide area. As far back as 1943, Soviet scientists worked out theoretically a method of making use of the moon as a space relay station. It involved focussing on the surface of the moon a narrow, highly directional radio transmission beam,



Communications satellites enable the reliable transmission of information over great distances. This Molnia-1 satellite launched in April, 1965, relayed colour TV programmes from Paris to Moscow and from Moscow to Vladivostok.

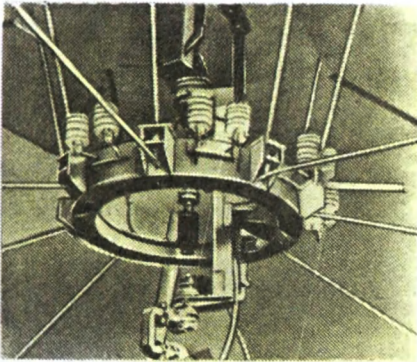
with the reflected signal being picked up on earth with the help of sensitive receiving equipment. The feasibility of the idea was proved in practice. Telegraphic communication via the moon was successfully established, and attempts were even made to transmit musical programmes. But despite the apparent simplicity of the idea its practical application would have been very costly, and there was the disadvantage that continuity of communication between distant points depended on their geographical position and the time of day.

It is quite another matter using artificial satellites, which do not simply reflect, but also amplify the signals from earth. Space radio links providing for communication over long distances for several hours at a stretch were established with the launching of *Molnia-1*, the first satellite of its series, on 23 April, 1965.

Since then the USSR has carried out regular launchings of *Molnia* satellites and modified versions of them. *Molnia* satellites have an elongated elliptical orbit, with an apogee of 40,000 km over the northern hemisphere, and they circle the earth twice every 24 hours. One of these circuits is such as to provide radio communication over practically the entire territory of the USSR for a period of about eight hours (the second takes the satellite over the Pacific and Atlantic oceans).

Experiments successfully carried out with *Molnia* satellites led to the development and exploitation (in late 1967) of the *Orbita*

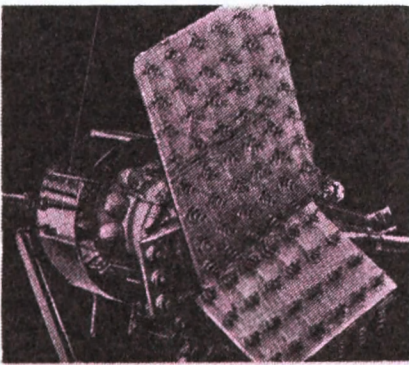
system of TV relay stations. These ground stations, of which there are nearly one hundred, located in different parts of the country, receive TV programmes relayed by *Molnia* satellites, and relay them to local TV stations which rebroadcast them. In this way there is high-quality long-distance TV coverage of a large part of



The Orbita network transmits TV programmes from Moscow to those regions where a system of ground relay lines is too costly. The equipment inside Orbita stations, as seen here, ensures good reception with minimum interference.

the territory of the USSR, taking in 83 per cent of the population of the country, who have some 60 million television sets.

Three further communications satellites—*Raduga*, launched in 1975, *Ekran*, launched in 1976, and *Gorizont*, launched in December, 1978, are in use. Their orbits are in the equatorial plane, and the satellites are stationary with respect to the earth because their orbits correspond to the earth's period of rotation. This means that receiving and transmitting antennae need to be set only once.



Ekran communications satellites, as shown here, are put into stationary orbits in the plane of the Equator, so ground reception antennae do not need to track them and can be of simpler design.

The *Molnia*, *Raduga*, *Ekran* and *Gorizont* complex of communications satellites make up the international system, *Intersputnik*, used by the socialist countries to meet the needs of telephone, telegraph and photo-transmission communications, and also for the exchange of television and radio broadcasting programmes. Besides the satellites, the system includes a Control

A Review of Hypotheses



CLARION

The name given to a hypothetical tenth major planet of the solar system. This, it is said, is where the "strangers" who visit the earth come from. In its dimensions and mass the planet is an exact twin of the earth, moving in the same orbit, but on the other side of the sun, like a counterweight. Because the sun is always between us, the planet is invisible from the earth.

However, there is no scientific substantiation of that theory.

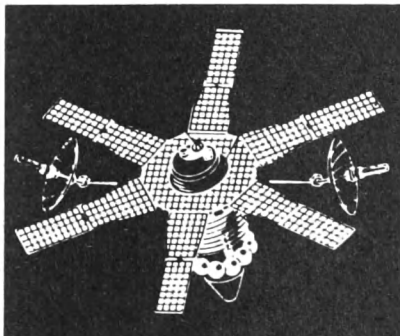
A Review of Events

Accomplished on 18 March, 1965, by Alexei Leonov from *Voskhod-2*, commanded by Pavel Belyayev. The cosmonaut was attached to the spacecraft by a life-line which allowed him to move away from the ship for a distance of 5 metres. The "walk" was for a duration of 12 minutes and was recorded by TV and cine cameras.

Ten years later, in July, 1975, Alexei Leonov commanded *Soyuz-19* launched during the Soviet-American *Soyuz-Apollo* mission.

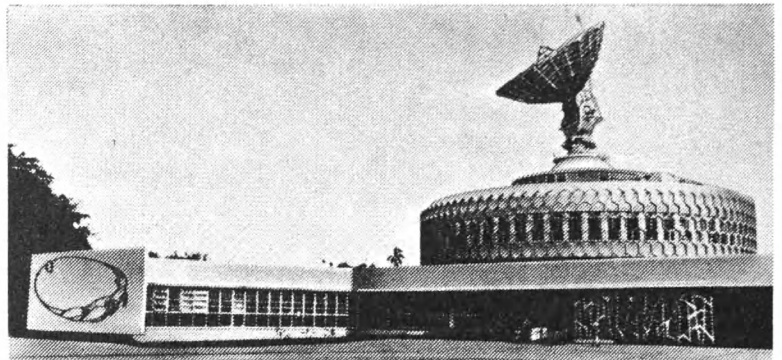
MOLNIA-1

The first generation of Soviet communications satellites, put into operation on 23 April, 1965. They have an elongated elliptical orbit (one revolution in 12 hours) which takes them about 40,000 km from the earth above the northern hemisphere, thereby maintaining radio visibility over a large part of the territory of the USSR for a relatively long period of time. They operate as reflector-amplifiers of radio and television signals. The second and third generation of *Molnia* satellites have a similar orbit.



Centre and eight ground stations—six in Europe (in the GDR, Poland, Bulgaria, Hungary, Czechoslovakia and the USSR), one in Mongolia and one in Cuba.

In accordance with an agreement concluded between the USSR and the USA, technical and organisational measures were



The Intersputnik international communications network relays TV programmes. Relay stations, like this one near Havana received TV pictures of the 1980 Moscow Olympics.

taken to establish two direct telephone channels between Moscow and Washington using the *Molnia* and *Intelsat* systems. The arrangement has been in operation since 16 January, 1978.

Sports lovers in all continents were able to see the 1980 Olympics in Moscow in their own homes—another benefit of space communication.

The benefits accruing from the technological achievement of satellite communication are probably obvious to all. Taking television alone, viewers have the opportunity to become acquainted with the latest events taking place in distant parts of the



world and with the world's treasurehouse of art, and the range of TV for educational purposes has been greatly extended.

Reliable long-distance communication links probably represent the first satellite achievement, which we immediately took for granted.

Other benefits brought to man by the space programme, though perhaps not so obvious, are certainly no less important—the study of the earth from space, for example, which Academician Roald Sagdeyev, director of the Space Research Institute, has called “astronomy in reverse”. This represents a new



Cosmonauts Viktor Gorbalko (USSR) and Pham Tuan (Socialist Republic of Vietnam). This crew visited Salyut-6 in July 1980.



Cosmonauts Yuri Romanenko (USSR) and Arnaldo Tamayo Mendez (Cuba) visited Salyut-6 in September 1980.

stage in principle in man’s scientific and technological advance, a stage which is now being called a “second overcoming of geocentrism”.

The first “overcoming” was the theoretical postulate of the great Polish thinker, Copernicus, that the earth was not the centre of the universe, but only one of a number of planets revolving around the sun. This notion, in the Middle Ages, represented an audacious contradiction of all accepted belief, and Copernicus decided to publish his work only late in his life. But the earth, even if reduced to the rank of just another body in space, remained for most people the only body, a practically limitless universe in itself.

The last two centuries have seen a change in man’s outlook. The effect of his activity on the surrounding world has come to be



A Review of Hypotheses



FLYING SAUCERS

The UFO’s, or Unidentified Flying Objects, first sighted by an American businessman, Kenneth Arnold, on 24 June, 1947, during a flight in his private two-seater plane. He reported seeing nine round, flashing objects, which flew over the mountains at a speed of about 1,700 m.p.h.

Arnold is reported as having said, in the summer of 1977, that he had never claimed to have seen any kind of little people in these objects. This - had been asserted by others, not by him, he said. Reports of UFO sightings swept the world, and from time to time there is a rash of new accounts of strange things seen in the sky. Some researchers claim to have discovered in legends and old chronicles references to what they term “palaeolithic contacts”, that is, to “beings from other worlds” who visited our planet in long-forgotten times. According to legend, it was these beings who taught mankind the use of fire, and provided the impetus for the subsequent development of the Creto-Mycenaean, Egyptian, Indian, Chinese and other cultures.

Flying saucer sightings were particularly numerous in the mid-sixties. The US Air Force was given the task of investigating the reports, but abandoned this work in 1970 after looking into 12,618 instances of sightings.

In 701 cases they could suggest no explanation for the sightings, but this was because of insufficient information or contradictory evidence.

In the summing up of the Air Force report it was stated that there was no evidence of any kind of visits to earth by inhabitants of other worlds, or of sightings of objects having a technological construction that could not be explained by present-day science.

Of course, this in no way rules out the possibility of the existence, in principle, of civilisations on other planets of the universe.

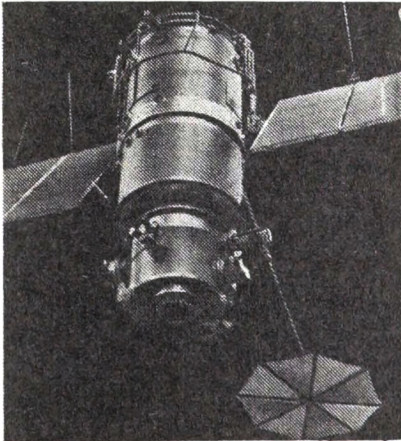
A Review of Events

Together with ground-based stations, the communications satellites comprise the *Orbita* system which became operational in November, 1967. Owing to the system, the greater part of the population of the USSR are able to receive television programmes from Moscow.

The cost of satellite communication does not increase with distance, as in the case of surface line-communication, and shows a cost advantage at distances over 800-1,000 km.

METEOR

The first meteorological satellite, launched by the Soviet Union on 26 March, 1969. Satellites of this series transmit continuous information on the cloud cover over the earth, the areas and intensity of precipitation, and on the movement of atmospheric fronts.

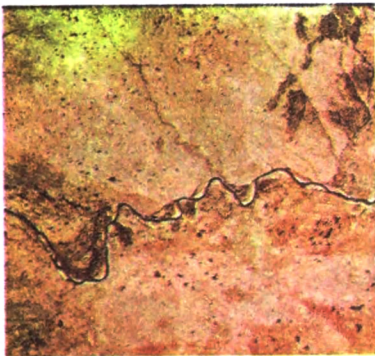


as great as that occasioned by natural disasters. The past 15-20 years have convinced nearly everyone of the error of regarding the earth any longer as an inexhaustible storehouse of the materials and energy resources needed by man, as a system which will automatically restore the fertility of the soil and the purity of the air and water. Our rapid scientific, technological and industrial development, too, is resulting in a "second overcoming of geocentrism".

Vitaly Sevastyanov, who has flown two space missions, told of his impressions while flying in orbit in these words:

"When you see how often man acts heedlessly in using the natural resources of our planet you feel sad at heart. Flying over Africa we saw forest fires, over Australia—more fires, Brazil and Canada—again fires. We passed over Sakhalin. Yesterday everything was as it should be. But today we spotted two incipient fires. We reported them, and did two more circuits. Earth replied later that they had despatched teams by helicopter to fight the fires."

Here we are dealing with something fairly straightforward: observation—reporting—action. But similar "observations" in



The Vilyui river area in East Siberia, photographed from the Soyuz-22 spaceship.

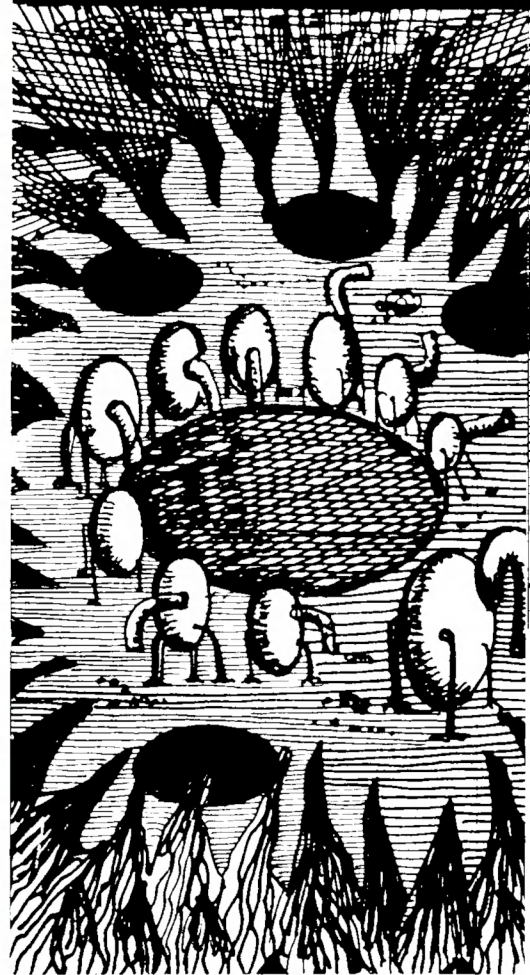


Distortion of colours on space photos enables the monitoring of even very slight deviations from normal in the growth of vegetation.

the scientific field, and the practical tasks associated with them, are, of course, of a much wider nature, and the research equipment needed for them requires the application of the most advanced technology.

When the USSR began using aerial photography in the nineteen thirties for the purpose of geological research, the immediate result was a mass of new and often unexpected information. But the possibilities of photographing from a plane are restricted, at best, to a field of view covering 200-300 sq. km. By photographing from space, however, an area of 1.5-3 million sq. km can be taken in on a single frame (i. e. a territory as great as that of the Mongolian People's Republic, or Mexico), clearly depicting the major structures of the earth's crust.

Admittedly this also has its disadvantages, for then there are problems of interpretation and deciphering, because the wealth



WATER-HOLE

The name given to radio waves of a certain frequency emitted in space by concentrations of intergalactic gases. These radiations occupy a space in the electromagnetic spectrum between the frequency of free atomic hydrogen and that of hydroxyl molecules. Combined, the hydrogen and hydroxyl form water—hence the name "water-hole" for emissions in this part of the radiofrequency spectrum.

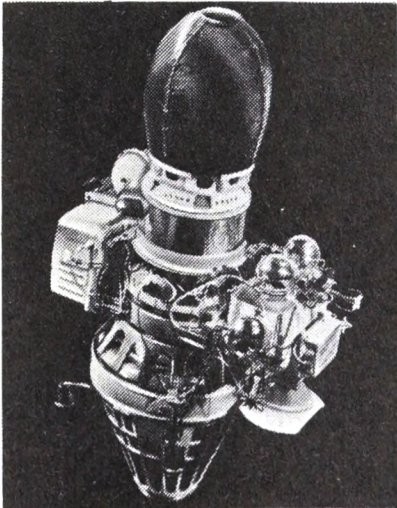
Science fiction enthusiasts and some scientists suggest that various forms of galactic life might communicate on these radio waves, in just the same way as different animals on earth meet at a water-hole.

A Review of Events

This information is of great assistance for more accurate forecasting of the weather, and hence is of correspondingly great economic significance. For example, it has been estimated that forecasting of 90-95 per cent accuracy, three days in advance, would represent a saving of 60,000 million dollars annually due to more efficient management in agriculture, municipal economy, etc.

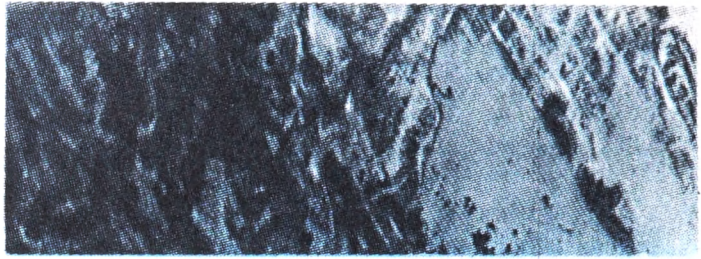
LUNA-9

The Soviet automatic station which made the first soft landing on the moon (3 February, 1966) and transmitted to earth TV pictures of the lunar surface.



of material contained in such pictures often cannot be packed into the customary form of presentation. At first, to interpret all the information contained in just one space photograph took nearly half a year, but now this time has been cut to a half or a third.

Multispectral photography is especially informative. This is carried out with a special camera, the MKF-6M, mentioned



Great geological structures are more easily seen from space and this helps scientists to discover mineral deposits.

earlier, developed by USSR and GDR specialists. The first model was tested in September, 1976 on *Soyuz-22*, which was manned by Valeri Bykovsky and Vladimir Aksyonov. Later, the advanced camera was used by Yuri Romanenko and Georgi Grechko for a valuable series of photographs taken from the orbital research station, *Salyut-6*.

Such a satellite-view of the earth is of great benefit not only to geologists, but also to specialists in many other branches of the economy, especially agriculture. Multispectral photographs of extensive areas of the USSR such as the lower Volga region, the area north of the Caspian, and the foothill regions of Central Asia help to establish workable deposits of oil and gas with greater



Detailed description of space photos in the process of their study.

accuracy, reveal areas threatened by erosion, and assist in deciding what action to take to protect crops and vegetation from the depredations of insects and other pests. Similarly, photo coverage of the country's mountain massifs—the Pamirs, the Tien Shan and the Caucasus—helps to evaluate the potential for hydroelectric development and to pinpoint places which might

be threatened by avalanches or slips or mud-flows of major dimensions.

By correlating the information received from an analysis of space photographs with existing data on natural resources, geologists have satisfied themselves that oil and gas deposits tend to be located in those parts of the earth's crust where there are major faults (and these faults can be perceived readily only from a height of several hundred kilometres). Useful mineral ores are concentrated in those places where fault lines intersect, and even coal deposits appear to be connected with the faults—a quite unexpected discovery for the prospectors.

Obvious, typical signs of the presence of useful minerals are stored in a computer memory system as reference standards, thus greatly facilitating the analysis of new space photographs. The computer may indicate, for instance: prospect here for copper, and at this point for oil . . .

The benefit of multispectral photography is perhaps even more strikingly apparent in the case of agriculture. The photographs of fields, orchards or forests printed out in "provisional", displaced colours (which might show forest, for instance, as red and water as black), immediately show which areas are maturing or ripening first, thus facilitating the organisation of the harvesting. And areas affected by blight or insect infestation show up clearly as a stainlike patch.

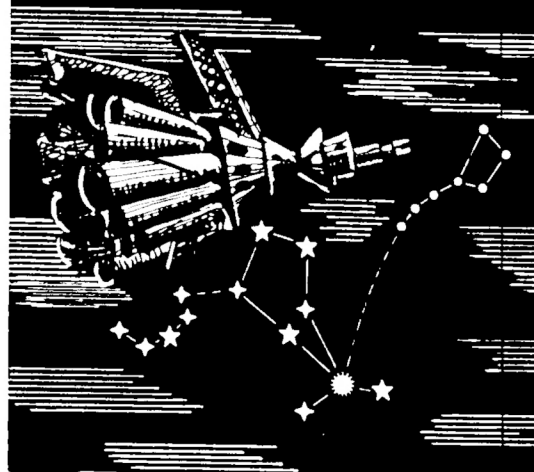
Less obvious, but also of great importance and significance are those services (and the work of different people) which make it possible to avoid many problems. For instance, thanks to satellite observations we are able to take timely action to deal with any threat to crops by insect pests, and to get the harvest in at the right moment, practically excluding losses—but we scarcely pause to note the fact. And when air services, whose operations are helped by navigation satellites, include regular, smooth-functioning long-distance flights, this is taken as a matter of course.

And already the results of man's launching out into space go far beyond the framework of these everyday matters and relate to questions of the most advanced technology, to the working out of principles for establishing the reliability of complex systems, and even to problems concerning the leadership and management of work collectives, for example.

An aspect of the space programme we have not yet touched upon is the connection between space flights and practical medicine. In the first years of man's flights in space, medical specialists had to solve a large number of complicated problems connected with ensuring for the crews a micro-environment as near normal as possible, and in this work they came up against quite unexpected problems. These required new approaches, and we heard a great deal about all kinds of miniaturised sensors and instruments, pressure-sealed helmets and electronic apparatuses, which would soon come to be applied in clinical practice as an aid to diagnosis and in deciding upon the most effective method of treatment in a given case. These predictions proved correct, and we may expect that the further the advances made in the field of space technology, the more this will benefit practical medicine.

Far more important though, as it turns out, is the contribution made by space research to medical specialists' knowledge of the human organism and of its reactions to stress situations and the changes it undergoes when exposed to, for instance, prolonged periods of weightlessness. Information of this type is available to the specialists, too, not only while crews are actually in flight, but also from the beginning, when they are first selected, and during the preparatory training period and under simulated conditions.

A Review of Hypotheses



STÖRMER'S PARADOX

The "radio echo", or time-lag in receiving radio signals reflected from some unknown body, discovered by the Norwegian mathematician, Carl Störmer, and confirmed by him in 1928 together with a radio amateur, Jorgen Hals, and a Dutch engineer, B. Van der Pol.

In 1972, a Scottish astronomer, Duncan Lunan, suggested that these delayed signals might have been caused by some robot-like cybernetic radio system which arrived in our solar system about 13,000 years ago. Lunan's theory is that this "robot" was sent to us from the star Epsilon in the Boötes constellation (104 light years distant from the earth), went into orbit around the moon and waited patiently until earthmen discovered radio communication.

At last, receiving radio signals from the first radio transmitters on earth, the "robot" began sending them back, with varying degrees of delay. The time-lag in each case indicated a certain point in a system of co-ordinates, and these points, taken together, took the form of a figure reminiscent of the constellation Boötes, giving rise to various "deciphering" theories. Störmer himself wrote that it had occurred to him that wireless telegraph waves might have been reflected by the electron streams in the upper atmosphere, which he had considered in studying the Northern Lights phenomenon in 1904-07.

A Review of Events

The landing of the station put an end to speculation that the moon's surface might consist of a layer of dust, many metres thick, which would "swallow up" any apparatus or manned spaceship sent to land on it.

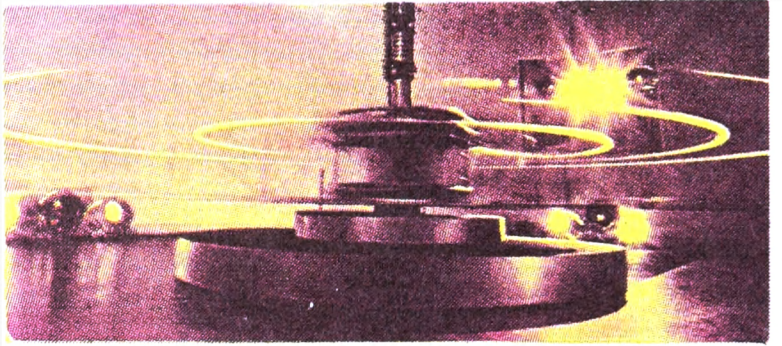
APOLLO-11

The spacecraft which took the American astronauts, Neil Armstrong, Edwin Aldrin and Michael Collins to the moon on 20 July, 1969. Armstrong and Aldrin landed on the lunar surface in a descent module,



One of the fields of study is the psychological compatibility of crews, especially when cosmonauts from different countries are involved.

At the time of the flight of Alexei Gubarev (USSR) and Vladimir Remek (Czechoslovakia), the officer in charge of the training,



Training in a centrifuge is a must for cosmonauts.

Lieutenant-General Vladimir Shatalov (himself a veteran of three space missions) told reporters: "To tell you the truth, when we began the training of international crews we had some apprehensions at first as to how effectively they would be able to work together—whether national habits and other differences in the way of life might not affect their compatibility. But our fears proved groundless. Now, in space, the representatives of our fraternal socialist countries have demonstrated their unity and comradeship, and judging by this result there is no need to change anything in the training programme for later crews."

However, this compatibility is partly due, also, to the application of new principles of forming work collectives. In particular, it became apparent that when people are working side by side it is

On June 11, 1980, leaders of the National Centre for Space Research in France introduced to pressmen two French pilots—Jean-Loup Chrétien and Patrick Baudry who had been selected for a future Soviet-French space mission.



best if they are talented specialists in widely different fields. It was found that the efficiency of collectives built on this principle rose not in proportion to the number of workers, but at a much steeper rate. Of course it is still necessary to take into account the individual idiosyncrasies of members of the group, for it is a



Academician Sergei Korolyov was director of the first Soviet space programmes.

necessary condition that the persons concerned respect one another.

Group leaders must display great tact and psychological flexibility. The late Sergei Korolev, the famous spaceship designer, was an outstanding leader of his team. A strong personality, he never sought to surround himself with obedient, colourless people lacking in competitive spirit, but was drawn to others with similarly strong wills.

This is how Sergei Korolev himself formulated his view of a good psychological climate in an organisation doing creative work:

"From many years of joint work at our undertaking comes this golden rule: every person must have the right, and indeed has the obligation, to express his opinion on any project under discussion, irrespective of the rank, title or seniority of the authors of the proposal. Don't signify meaningless agreement, but criticise if need be, propose other ways, uphold your specific point of view—you can be sure that nobody will reproach you for this."

But the question then arises: have such collectives been able to exert an influence on technological progress? Has there, in fact, been a significant advance in the industrial process? The answer is without doubt in the affirmative. The technical experts say that the most important effect of the space programme on production has been a marked rise in quality. The thousands of interacting systems and millions of individual parts in space apparatuses has meant that the design engineers have had to introduce completely new standards of quality, and continually concern themselves with the questions of accuracy and reliability.

Some simple arithmetic shows the magnitude of the problem. Take, for example, a piece of equipment with a 99.9 per cent reliability rating (normally a high figure). This allows for the possibility of the failure of one part in a thousand. But a spaceship launch vehicle is made up of about five and a half million parts, which means that with the above reliability rating there could be 5,500 faulty parts. Even though a large number of these millions of unit parts represent assorted screws, nuts and washers with very close 100 per cent reliability, among the 5,000 or so parts

A Review of Hypotheses



LEO (THE LION)

One of the constellations indicated, the enthusiasts say, as a result of their attempts to decipher "coded messages in the form of a series of intervals of radio echoes".

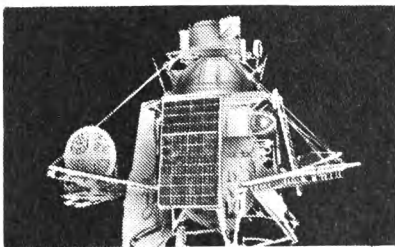
A Soviet engineer, Pavel Gilev, from the town of Ust-Kamenogorsk, thinks that a "probe" is indicating the co-ordinates of the star Theta in the constellation Leo. The Bulgarian astronomer, Ilya Iliev, however, is of the opinion that the "stranger" comes from the star Zeta, of the same constellation.

A Review of Events

named "Eagle", and on 21 July left the cabin and spent some two and a half hours on the moon, where they placed instruments and carried out a programme of research. Having accomplished their mission the two astronauts blasted off and linked up with the orbital section, "Colombia", which during this time had been piloted by Collins, and the three men returned to earth safely.

INTERCOSMOS-1

The first of a series of satellites, put into orbit (on 14 October, 1969) under the programme for co-operation in space research agreed upon by the socialist countries in April, 1967. The *Intercosmos* programme provides for the investigation of a wide range of scientific problems in five main directions: study of the physical properties of space, communications, space biology and medicine, meteorology, and study of our natural environment from space.



there could well be some whose failure might lead to vitally important systems being put out of action. And to back up all systems would be very difficult—and would still not afford an adequate guarantee.

To ensure maximum possible safety for manned space flights, therefore, the reliability rating of manufactured parts must be no less than 99.999 per cent—the practical limit possible with present-day technology.

The branches of industry working to meet the requirements of the space programme profit from this because they must constantly, from day to day, introduce and employ only the most advanced technological methods, the very latest achievements of the engineering world, and this experience is then transferred, or spreads over, to other spheres.

With this is closely connected another aspect—the high degree of perfection achieved in computer technology, and the remarkably small dimensions attained with these machines. The tiny pocket calculators which have flooded the world market owe their appearance to the microminiaturization of integrated circuits. By employing a special method of spraying to build up successive layers of different materials, it is possible to pack into the space of a few cubic millimetres the equivalent of tens of thousands of transistors, diodes, capacitors and resistors.

It is a little premature as yet to claim that such machines can "think", but none the less they are capable of controlling an apparatus to follow a programme of considerable complexity, selecting from among many options the optimum "course of action". This is especially important where research equipment must operate automatically—for instance, on the probes sent to study Venus and Mars. The Soviet station, *Mars-3*, which made a soft landing on Mars, provides an example. On approaching its destination it made its own last-minute course corrections as instructed by the on-board computer. This was necessary because of the communication time-lag (at this distance a radio signal takes twenty minutes just to cover the one-way journey from Earth to Mars).

Despite the staggering immensity of astronomical distances (of which we can only have a hazy concept), instruments have been developed to measure them with a great degree of accuracy.

The *Lunokhods*, the Soviet Union's mobile laboratories, which worked on the surface of the moon in 1970-71 and 1973, were fitted with French-made specially designed angular reflectors for reflecting laser impulses sent from earth back to the precise point of their origin. By measuring the time taken for these impulses to make the journey there and back (a total of nearly 800,000 km), it was possible to determine the distance between the earth and the moon at the time of measurement to within a fraction of a metre.

Of course, such information does not seem to have any obvious connection with everyday life. But there exist many phenomena of great practical significance, the nature of which science is still unable to explain fully. For instance, many scientists are of the opinion that the catastrophic earthquakes that take place periodically are due not only to forces emanating from deep inside the earth, but also have some connection with the gravitational force exerted by the moon—a force which is variable, depending on the distance of the moon from the earth at any given point of its orbit. By determining these varying distances accurately and recording the time of measurement, and comparing the results with seismological records and the places where earthquakes have occurred, it might be possible to establish a connection and on this basis to predict the likelihood and the time of future disasters.

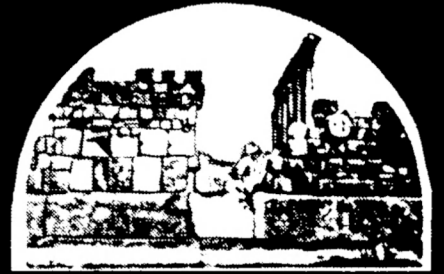
This is only one example of many, all of which go to show that the space programme does, in fact, bear a close and direct relationship to our ordinary living, our everyday activities and interests.

But there is another aspect, too, to the study of the mysterious world of space—a psychological one.

How has the cosmos influenced the spiritual world, the world outlook of man? Has our perception of the world around us changed? Do we love and hate in a different way, or, on the contrary, are we stagnating out of indifference?

What has the space age opened up for us in this respect?

A Review of Hypotheses



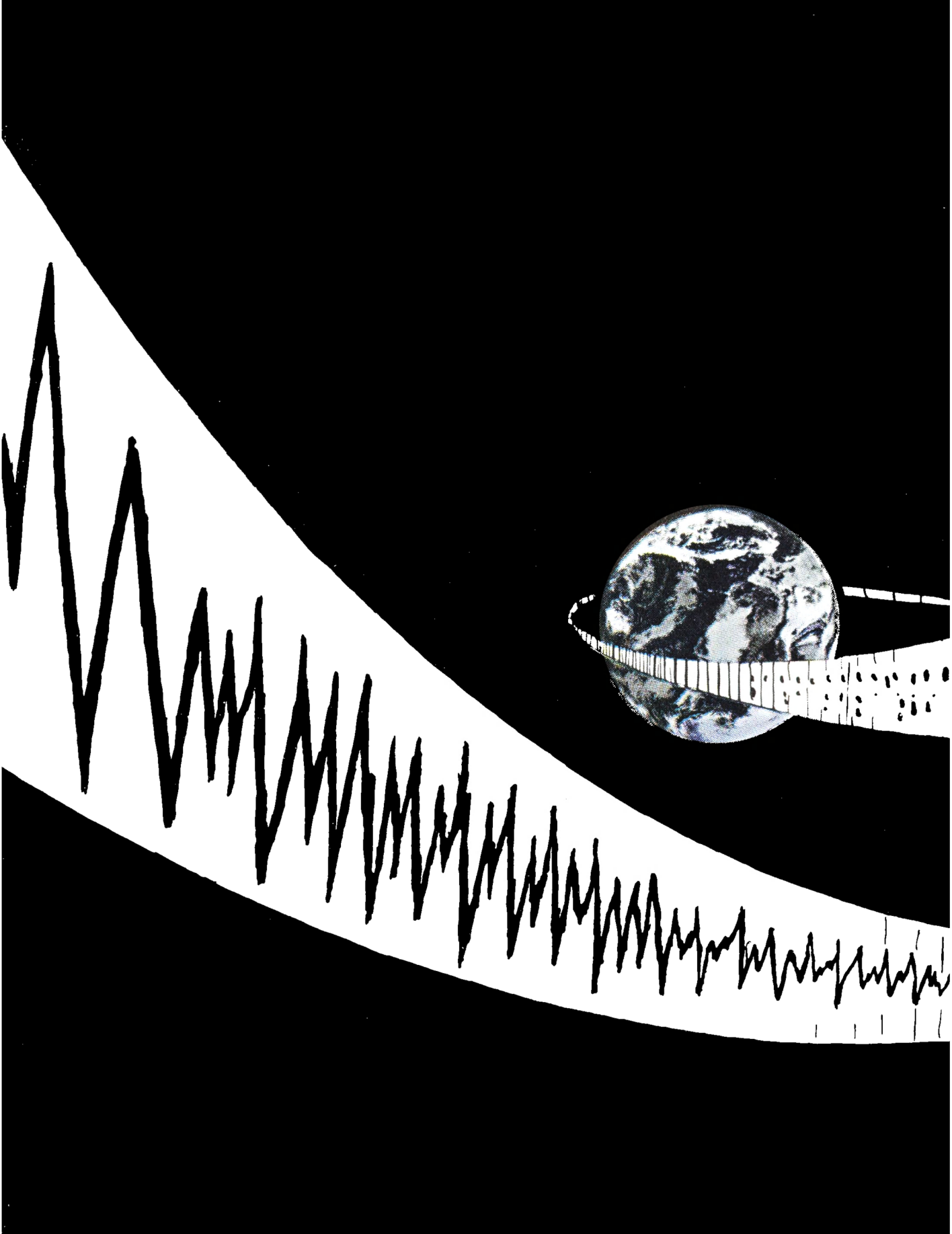
BAALBEK

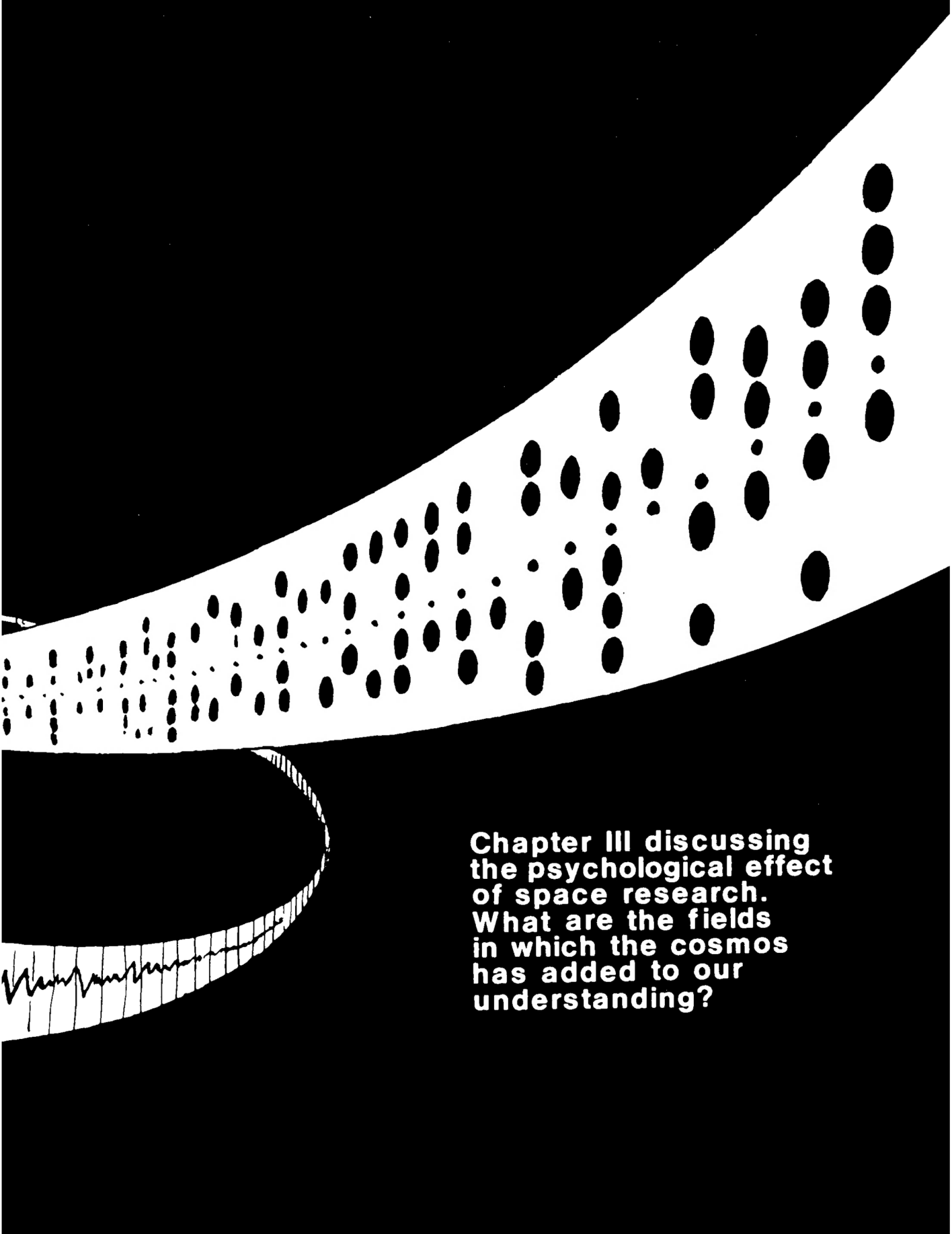
The name of the town in Lebanon, that 2,000 years ago was called Heliopolis, after the sun. Scientists argue about how the Baalbek terraces came to be built (they are reckoned to have been constructed about 2600 B.C.).

They are located in the Bekaa Valley, between the Lebanon and Anti-Lebanon mountain ranges. In one part of the terraces lie three stone monoliths weighing "a thousand tons each", according to several sources. It has been suggested that the platform formed by these monoliths was not made by human hands, but represents a "landing and launching platform for spaceships".

However, our ancestors unquestionably had the ability to put up enormous constructions without "outside help" and to move astonishingly large and heavy objects about with the very simplest technical means.

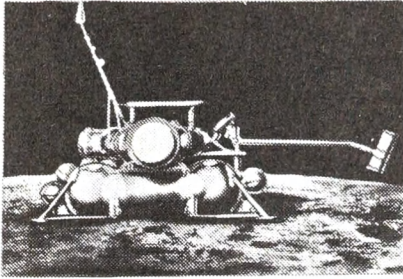
Take, for example, the huge block which forms the pedestal of the Bronze Horseman in Leningrad. The weight of this stone, found in the 18th century in north-west Russia, is more than 1,600 tons. But the builders, using only levers and ropes, hauled the giant boulder onto a timber platform, which rested on brass balls running in grooved guide rails. By this means it was brought to St. Petersburg, taken across the Neva (without once having to call on any "outside help"!) and set up on the square where it sits to this day.





**Chapter III discussing
the psychological effect
of space research.
What are the fields
in which the cosmos
has added to our
understanding?**

A Review of Events



LUNA-16

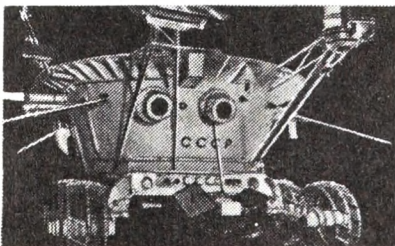
The Soviet research station which, on 24 September, 1970, marked a new advance by delivering samples of lunar rock to the earth entirely by automatic means.

The flight was a convincing demonstration of the advantage of fully automatic probes for conducting efficient, safe and economical research at distances far from the earth.

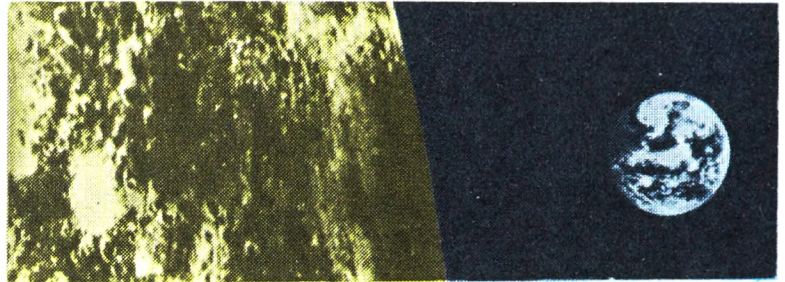
Further similar research was conducted, and additional samples of moon rock were delivered to earth by the automatic stations *Luna-20* in February, 1972, and *Luna-24* in August, 1976.

LUNOKHOD-1

The first mobile, remote-controlled space laboratory, carried by a Soviet station and placed on the moon's surface on 17 November, 1970, where it worked for ten and a half months. The programme of research was continued in



It has been noted many times already that only after penetrating the earth's confining atmosphere did man begin to have a true appreciation of the place and scale of his planet in the system of the universe.

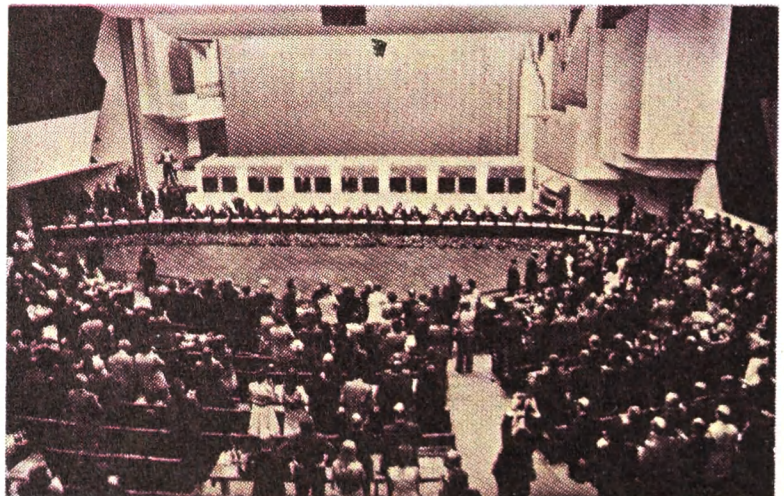


This is what the earth looked like from the Zond-6 space probe as it rounded the moon and headed for the earth.

Those 108 minutes spent in space by Yuri Gagarin, the first man to observe our earth from the outer void, had the immediate effect of shrinking the world, of reducing the distance between the continents.

And not only this. Our vast, boundless earth took on a different aspect—that of a small, close-packed, pale blue planet in the black ocean of the universe. With this revelation, this new conception, people began to feel much more acutely that the earth, far from being considered—as in the past—as an object of conquest, stood in urgent need of protection from the ravages of man, that it was like a "spaceship" equipped with a well-

The 1975 Helsinki Conference on Security and Co-operation in Europe. TV reports of the conference were relayed by space communication channels.



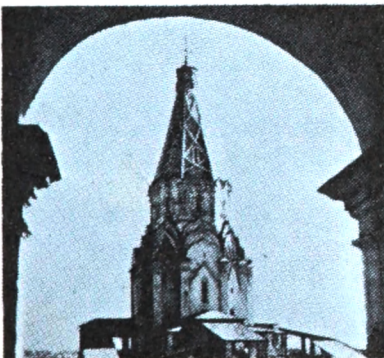
established biological chain of connections, a closed-cycle natural purification system. Although there is an astonishing diversity of these living chains, their number is none the less limited, and by continually acting to disrupt the delicate ecol-



Ground stations receive reports sent by weather satellites.

ogical balance, mankind runs the risk of eventually causing the breakdown of his own "life-supporting system".

This has become a global problem, as reflected in the Final Act of the Helsinki European Security Conference in an article which states that "economic development and technological progress must be compatible with the protection of the environment and the preservation of historical and cultural values; that damage to the environment is best avoided by preventive measures; and that the ecological balance must be preserved in the exploitation and management of natural resources".



The further we advance into space the more we cherish the heritage of our past, like the Church of the Ascension at Kolomenskoye in Moscow.

Space research is making an important contribution to the observance of the above points, helping to make the first, perhaps still timid, steps in reorganising our psychological perception of the world. Only quite recently, when the practical

A Review of Hypotheses



DEVIL'S RINGS

The luminous circles observed by seamen in different regions of the World Ocean. They sometimes attain a diameter of 600 metres, and the revolving part, a speed of up to 160 kilometres per hour.

Catastrophes and queer happenings have taken place in the areas where these rings have been observed. In 1884, the Portuguese brig, Santa Maria, was found with all its crew dead. In 1948, in the Straits of Malacca, a Dutch freighter, the Orang Medan, sent out a distress call. Rescue ships from Singapore and Sumatra found the Dutch vessel, also with all its crew dead. . . But whether there is any connection between these tragedies at sea and the "Devil's rings" remains unknown. And where there are inexplicable mysteries there are always people ready to ascribe them to "flying saucers".

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January, 1973, by its successor, *Lunokhod-2*.

Power was supplied by accumulators charged by solar battery panels, and the vehicles were controlled from earth by a tele-automatic system. Sturdy and reliable, the *Lunokhods* explored kilometre after kilometre of the moon's surface, transmitting a wealth of information on the ground covered and on the properties of the lunar soil.

SALYUT

The series of orbital scientific stations intended for long periods of research work by two, three or more persons. The stations carry a comprehensive range of scientific equipment, and substantial stores of provisions, water and oxygen. They are launched without a crew, who man the station later, transferring from a transport spacecraft of the *Soyuz* series. Cargo spacecraft (the *Progress* series) deliver fuel and other necessary supplies to the station. The first *Salyut* station was launched in the spring of 1971, and its crew of three—Georgi

uses to which space achievements might be put were being discussed, emphasis was on the observation services that could be organised to aid the fishing industry, telling the fishermen of the location of shoals of fish. This example, of course, was



Commemorative emblem attached to the Soviet rocket which placed the French Signe-3 satellite in orbit on June 17, 1977.

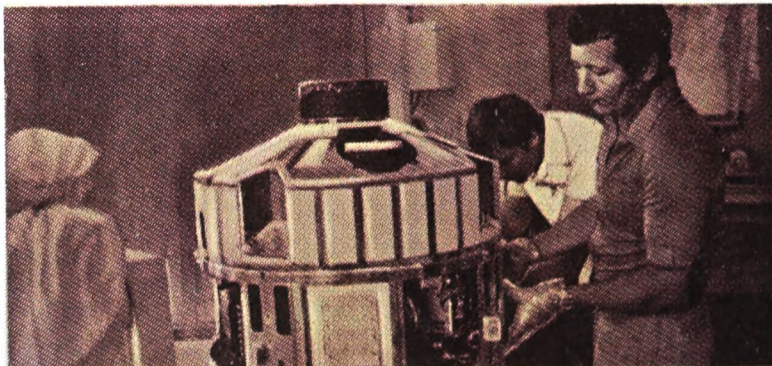
borrowed directly from aerial survey practice, but going a stage higher where there is a more comprehensive view.

Today the discussion takes an entirely different turn, and we hope to benefit no less from space services which, with scientific objectivity and authority, recommend where *not* to fish, and tell us which particular forested areas should be fully protected, and why, or in what water catchment area a prohibition should be imposed, until further notice, on the discharge of industrial waste.

Academician Alexander Sidorenko, Vice-President of the USSR Academy of Sciences, expresses his opinion in this way:

"There can be no doubt that the programme of earth studies from space must be based on wide international co-operation. The world is a home which we all live in, and people will together

In an assembly-and-test building at the cosmodrome French specialists test the Signe-3 satellite systems before launching.



solve the problem of preserving the natural environment for themselves and for posterity.

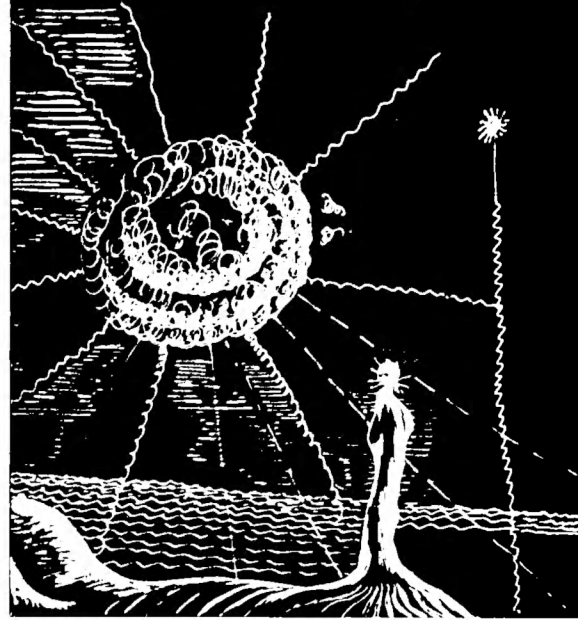
"It is clear that what has been achieved today represents only the first steps on the way to an active exploration by mankind of a world beyond the confines of our planet, in the interests of a better life on earth. We can be certain to hear more about new, important discoveries and interesting projects which will be accomplished by the joint efforts of scientists of different countries."

Joint effort is an acknowledged method of hastening the progress of science and technology. The realisation that the inhabitants of our small planet earth must tackle global problems together has also been strengthened by the space age. Soviet scientists work in close co-operation with scientists in socialist countries. Striving for a steady relaxation of tension in international relations, they are constantly widening their contacts with capitalist countries. In recent years the USSR has concluded inter-governmental agreements on co-operation in such fields as the peaceful use of atomic energy (with the USA, Sweden and Finland), space research (with France and the USA), study of the world ocean (with the USA), environmental protection (with the USA, Great Britain, France, Belgium and Italy), health and medicine (with France, Italy, the USA and Britain), agriculture (with the USA and France), and transport and building (with the USA).

The planning of co-operative research of this nature envisages not only work on today's pressing problems. In the course of joint study a store of knowledge is also being amassed in the sphere of the fundamental sciences. And this knowledge helps to sweep away old stereotyped ways of thinking, changing the world-outlook of people and their ethical relationship to one another. The reason for this is that by coming to understand the fundamentals of a given process we have the possibility of influencing this process. If we cannot change the laws of nature we can at least learn to make intelligent use of them.

The seemingly abstract argument as to whether mankind occupies an "ordinary" or "exclusive" place in the universe is by no means just a rhetorical exercise, as first appearances might suggest. Conceptions upheld by one scientific school of thought or another frequently exert a long-term influence on the kind of

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SODOM AND GOMORRAH

The towns in the Middle East at the mouth of the River Jordan, the inhabitants of which, according to legend, gave themselves up to a life of debauchery and depravity, for which the god Jehovah rose and destroyed them and turned their land into a lifeless desert.

This act of destruction is said to have taken place about 4,000 years ago, and there are some who claim that the towns were razed to the ground as a result of an atomic explosion, the culprits being (once again) visitors from other worlds.

According to the Bible, the only people to survive the catastrophe were Lot, the herdsman, and his family, but his wife, with the curiosity of her sex, peeped to see the flaming Sodom, despite having been warned not to do so, and as punishment was turned into a pillar of salt.



A Review of Events

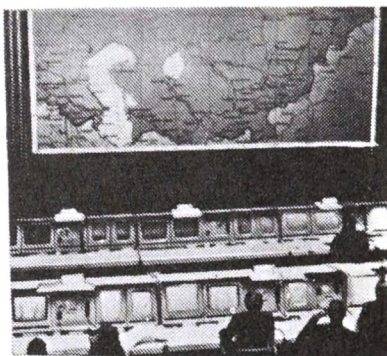
Dobrovolsky, Vladislav Volkov and Viktor Patsayev—carried out a programme of work on board the complex from 7 to 30 June. But the mission ended tragically, when the *Soyuz-11* descent module bringing the crew back to earth became depressurised. The three cosmonauts perished. A great deal of work has been carried out aboard later *Salyut* stations by successive crews. *Salyut-6* has been in service for about four years.

SOYUZ-APOLLO MISSION

The joint experimental flight in July, 1975, accomplished by Alexei Leonov and Valeri Kubasov, manning *Soyuz-19* and Thomas Stafford, Donald Slayton and Vance Brand, in *Apollo*. The flight was preceded by a large amount of work by specialists of both countries, involving the designing of a compatible docking system for the linking of the two craft, and the working out of a method



career chosen by young people, accelerating technological development in one direction and holding it back in another. Take the case of a talented youth who decides to make mathematics his career. His work will almost certainly be connected in one way or another with space physics, space chemistry or the theories



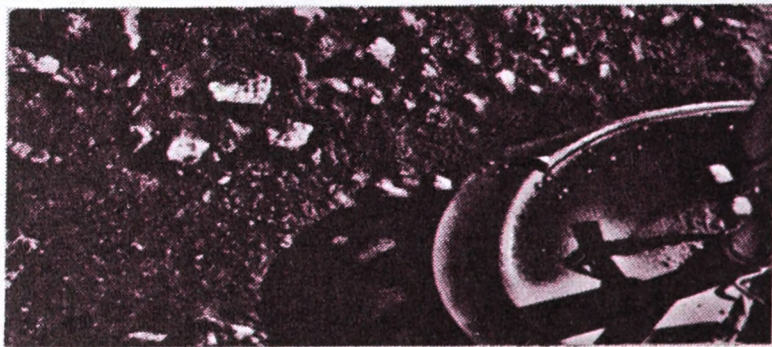
Flight control centre. Here scientists, designers and space medicine experts check the parameters of the spaceship's orbit, the functioning of life-supporting systems and the health of space crews.

concerning the origin of the universe. It is the mathematicians who determine the trajectories of interplanetary flights and the launching times.

The guidance systems used for the control of space complexes make use of high-speed computers, for there are a large number of calculations to be performed, including the processing of telemetered information and the mathematical modelling of many different operations.

The *Salyut-Soyuz* complex, for example, was equipped with more than 3,500 telemetric sensors, from each of which information was obtained in pulse signals with a frequency range of from once a minute to 100 times a second. The volume of telemetered information received at the Ground Control Centre in just one communications session with the orbital complex might exceed 100 million binary digits—about the same as would be necessary to transmit, word by word, the information contained in a thousand newspaper pages. And taking into account, also, that

Martian soil... So far it has not provided any definite answer as to whether or not there is life on the planet.



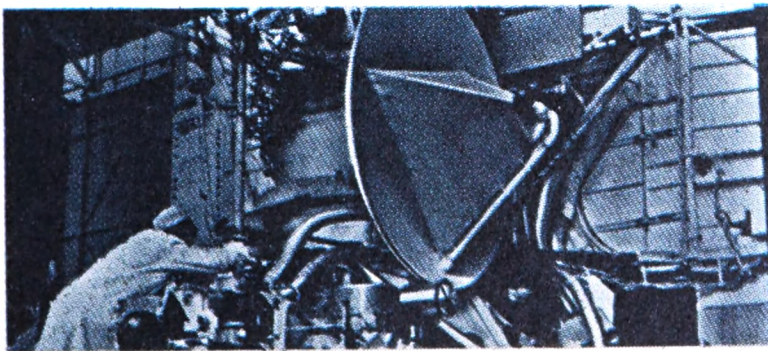
there are ten or more of these sessions in a 24-hour period, this will give some idea of the work-load falling to the lot of the mathematicians. At any given moment Ground Control must have accurate information on the conditions under which the cosmonauts are working, how they are coping with the programme of experiments, and whether the on-board systems and installations on the complex are functioning normally.

To ensure maximum safety and reliability in space in the event of unforeseen, "unscheduled" situations, a mathematical model of the spacecraft or a control duplicate is created. Such a model includes an analogous computer complex, simulated external bodies (the sun and earth and stars as seen through the portholes of the spacecraft), and a cabin mock-up, the controls of which operate as an extension system of the computer complex.

Here we have been considering the case of mathematics. And what if one's chosen career is biology? The situation here is even more involved. There is still no end to the debate as to the beginnings of life. Did it originate on earth or in the mysterious, unknown depths of the cosmos? There are persuasive arguments for both points of view. Scientists of the two schools of thought waited with bated breath for the results of the analysis carried out on Mars by the American probe, *Viking*. If convincing evidence could be found of the existence of life in some form in the Martian soil, this would be a triumph for the "cosmic" school, and for the others—catastrophe, the collapse of a great theoretical edifice, with perhaps disastrous consequences for scientific careers. As it turned out the evidence could not be counted as conclusive one way or the other, and so the question remains for the time being open.

The fewer the facts, the greater the scope for conjecture. Less than twenty years ago science fiction writers described the "jungles on Venus", teeming with strange and fearsome creatures, or "oceans of oil" on that planet. Then the first Soviet automatic probes transmitted back to earth factual, and in many respects astonishing information. In 1967, *Venera-4* reported that the Venusian atmosphere consisted almost entirely of carbon dioxide, and that the temperature on the surface of the planet was in the order of hundreds of degrees. There could be no more talk of "jungles"—this was clear.

Venera-9 in an assembly shop before being taken to the launching site.



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TUNGUSKA METEORITE

Name of the unknown body which caused the tremendous explosion that took place in the Siberian taiga on 30 June, 1908. Specialists say the blast was approximately 1,000 times more powerful than that of the atom bomb dropped on Hiroshima in 1945.

But what precisely was this body that penetrated the atmosphere? A Soviet science-fiction writer, Alexander Kazantsev, in 1946, maintained that it was a "Martian spaceship", which had come to grief in the region of the river Podkamennaya Tunguska. But all attempts to detect any residual radioactivity (such as would certainly exist if the explosion had been a nuclear one) have been fruitless.

Soviet Academician Georgi Petrov suggests that the unknown object could have been a gigantic lump of loose snow and dust, with a diameter of about 600 metres and a density approximately one-hundredth that of water. Approaching the surface of the earth, this enormous "snowball", upon encountering the resistance of the atmosphere, would have generated a mighty shock-wave and attained a temperature of 30-40,000 degrees. The forest was flattened over a large area, which then became an inferno of fire. This hypothesis tallies well with mathematical calculations.

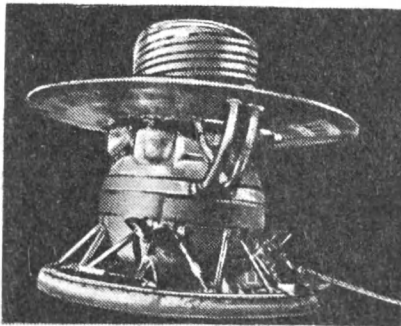
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allowing for the transfer of the cosmonauts from ship to ship (since the composition and pressure of the atmosphere maintained in the cabins of the two craft differed). Agreement also had to be reached in the planning stage as to the methodology to be adopted in carrying out joint observations, the question of flight control, and on the exchange of information.

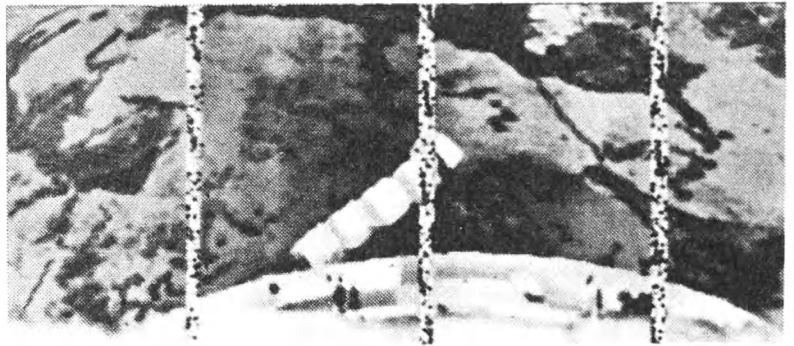
VENERA-9 and 10

The Soviet interplanetary automatic stations which became the first artificial satellites of the planet Venus. Descent modules from the two stations landed on the Venusian surface in October, 1975. As they passed through the dense atmosphere surrounding the planet, slowed down by braking parachutes, they confirmed the information received from previous stations as to the chemical composition of the atmosphere, and recorded the surface pressure and temperature.

All the data transmitted by the modules was picked up by the



Subsequent research probes confirmed these findings, and the *Venera-9* and *Venera-10* missions made a signal contribution to present-day scientific knowledge. In October, 1975, descent modules parted from their parent stations and succeeded in soft-



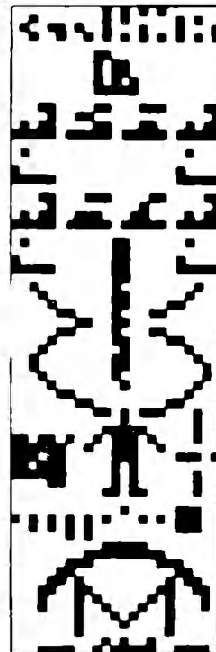
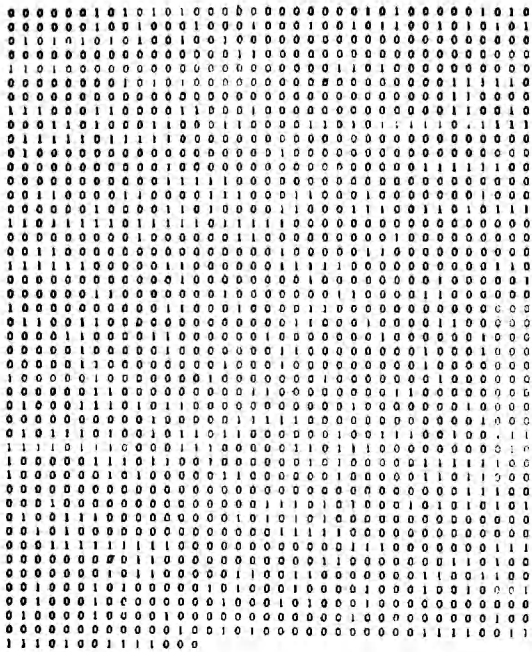
This panorama of Venus taken by Venera-10, like all the other photographs of the surface of our mysterious neighbour, the Morning Star, made scientists think hard. Just one of the many puzzles is why are the edges of the rocks sharp instead of smooth due to weathering?

landing on the surface of Venus, from where they sent back clear pictures with good definition, providing a panorama of the immediate surroundings. The pictures provided much new information, and at the same time posed new problems.

The American journal, *Science News*, published one of the pictures under the heading "Grand Unveiling of the Rocks of Venus". But the photographs brought with them further mysteries: the sharp edges of the rocky outcrops, with hardly any sign of weathering; the unexpectedly high level of illumination (similar to that on earth on an overcast day) despite the planet's dense cloud layer; and the crisp, well-defined shadows—which should have been weak and hardly in evidence considering the diffusion afforded by the unbroken cloud cover . . . All new puzzles over which to rack one's brains.

The well-known British astrophysicist, Sir Bernard Lovell, described the *Venera* flight as marking a new stage in man's technical achievements, which, undoubtedly, would soon allow us to make a more definite assessment of our place in the universe.

As we see, the question of mankind's place and role in the cosmic order of things is increasingly coming to preoccupy the minds of scientists. And this is by no means a purely academic question. Are we unique, alone in the universe, or does life exist somewhere else, other than on earth? When man finally embarks upon distant journeys to other planets and to stars, will he encounter intelligent beings? And if the earth represents only a tiny microcosm of life, which arose as a result of an exceptionally rare combination of favourable circumstances with a practically



Mankind has at last made an attempt to establish contact with other intelligent beings. Using the binary code it has sent information about the solar system and the earth's inhabitants in the direction of the Messier star cluster. Any intelligent beings who may be there will receive this message in 24,400 years' time.

zero probability of their being repeated anywhere—does this mean we are doomed to eternal cosmic loneliness?

We cannot reconcile ourselves to such a view, and hence the great interest in the possibility of finding civilisations somewhere else in the universe, and in newspaper reports of some cosmic probes from another planet in orbit around the moon, or the sightings of flying saucers. The credibility of the authors of these accounts is immaterial. The papers carrying the reports are eagerly snapped up and the stories swallowed whole (especially when sensationally presented with dramatic details).

Some UFO investigators suspect that these "visitors from other worlds" are carefully observing us, and one American scientist has even suggested that our galactic neighbours have declared the earth to be a kind of cosmic reserve, and that we ourselves are the result of a laboratory experiment organised by some kind of "super-beings".

Theories of this kind, however, are not supported by any conclusive evidence, the occurrences are not repeated, so there is no possibility of verification, and popular articles on the subject seek to explain the inexplicable only with the help of still more far-fetched ideas.

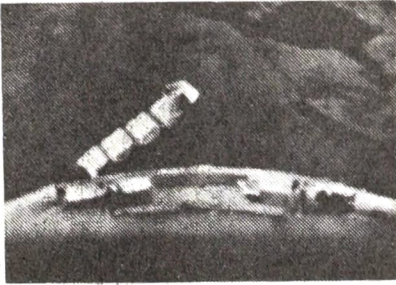
Clearly, the present stage arrived at by mankind as a result of the scientific and technological revolution is not simply one of a widening of our possibilities or of having a mass of new

BERMUDA TRIANGLE

An area in the western part of the Atlantic Ocean bound on the north-west by a line running from the Florida peninsula to the Bermuda Islands, by the Bahamas on the south-west, and on the east by a line of longitude approximately 65° West. It acquired this name after the mysterious disappearance here, on 5 December, 1945, of five US Navy torpedo planes which were on a training flight, followed by the disappearance of a well-equipped air-search flying-boat and its 13-man crew.

For a long time now this area has been noted for the number of disasters occurring here, involving both ships and aircraft, and considerable loss of life. In the last thirty years more than a thousand people have perished or disappeared without trace in the "Bermuda Triangle". These facts have given rise to much speculation, fanciful theories that the "triangle" is a kind of "hunting ground" for beings from the other planets, who snatch up earth-people for some reason or other.

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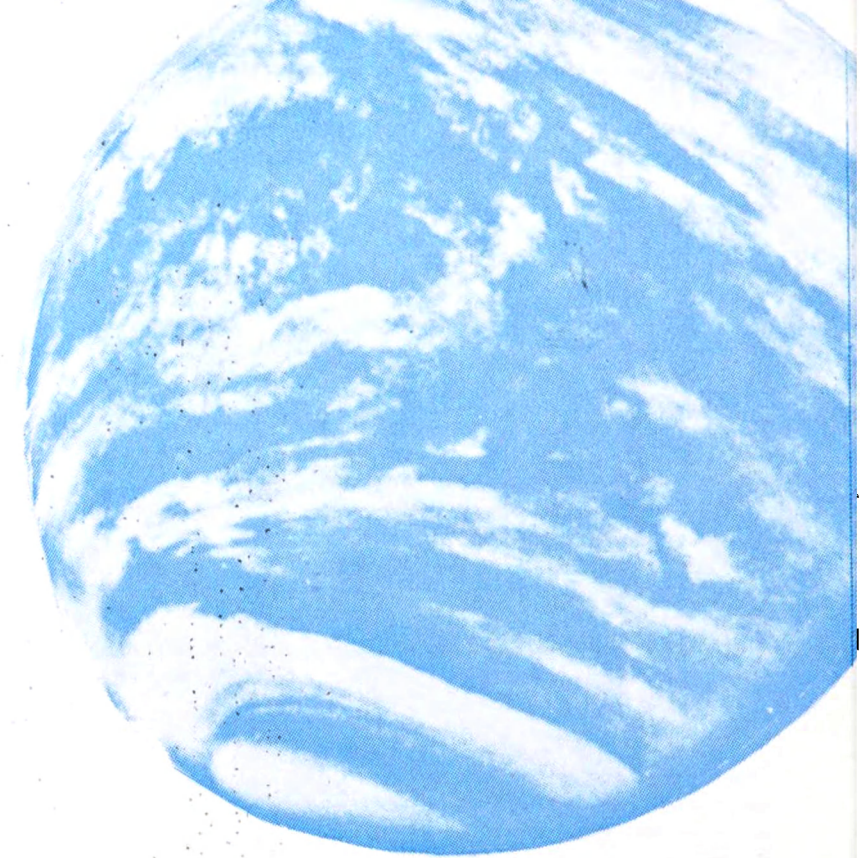
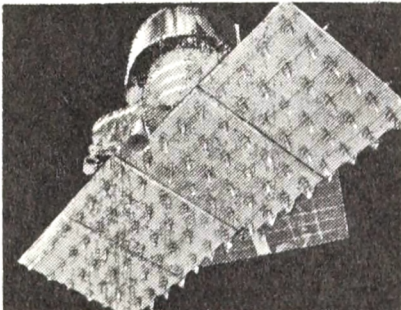


orbiting stations and relayed by means of highly directional antennae to tracking stations on earth.

The pictures of the surface of the planet were a triumph for the planners and designers, who had not been sure that there would be sufficient light on the surface in view of the permanent heavy cloud layer that blankets Venus. But the level of illumination proved higher than expected, and television pictures of high quality were received. They posed a new riddle—the mystery of the sharp edges of the Venusian rocks, which showed practically no sign of the wear that one would expect to have taken place through the action of the burning hot atmosphere.

RADUGA, EKLAN AND GORIZONT

Retransmitting communications satellites put into stationary



information. The quantitative accumulation of new knowledge has already led to a qualitative change in our world-outlook. In extending the boundaries of his knowledge and penetrating the depths of space, man is increasingly coming to use the pronoun "we", imbuing it with an ever more profound meaning. And perhaps one of the most important results of this process is the dawning realisation that it is possible to resolve conflicts in our present-day world without resorting to arms.

"Peace will become truly durable when it is the main goal and criterion of the policy of all states, when the approach of governments to problems that arise is determined not by fear of one's neighbour, but by a conscious striving to co-operate with one another honestly, to reach agreement without detriment to the security of others."

In the context of the Space Age, these words spoken by Leonid Brezhnev, General Secretary of the CPSU Central Committee and Chairman of the Presidium of the USSR Supreme Soviet, recall

the agreement concluded between the Soviet Union and the United States in 1972 on co-operation in the exploration and use of outer space for peaceful purposes, an agreement which envisaged the planning of joint space flights.

The year 1975 saw the first fruits of this co-operation with the joint *Soyuz-Apollo* experimental flight accomplished by Alexei Leonov and Valeri Kubasov for the Soviet Union and Thomas Stafford, Donald Slayton and Vance Brand for the United States. It was an historic occasion, not only because of the flight itself, but also because of the manner in which it was accomplished. About a thousand million people must have seen and heard the press conference held out in space, which began with these words by Thomas Stafford:

"Yesterday, when I first opened the door of the lock and said 'hello' to Alexei and Valeri, I was thinking that by opening doors in space we open up a new era in mankind's history and that this era has a bright future."

Alexei Leonov added:

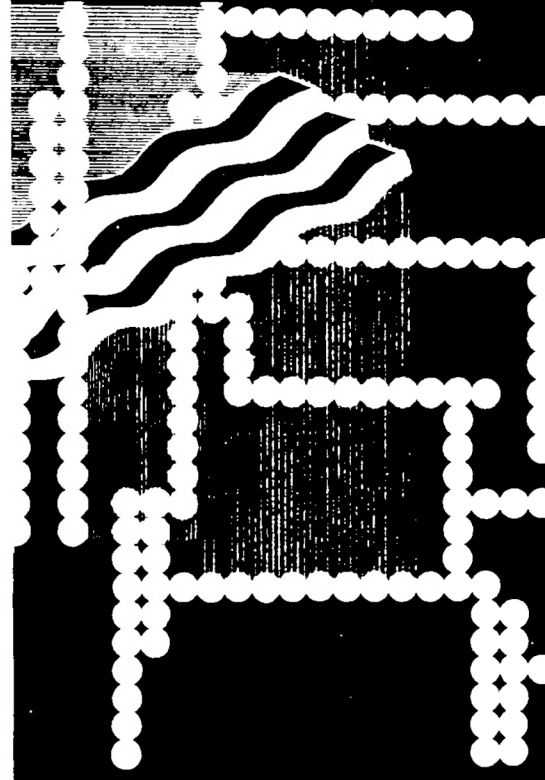
"We, the representatives of two countries, are accomplishing this joint flight because our peoples and governments wish to work together in a spirit of co-operation. . . ."

The atmosphere of cordiality and mutual understanding did not end with the completion of the mission. Later in the year the

Soviet cosmonaut Alexei Leonov and American astronauts Thomas Stafford and Donald Slayton during the joint space flight in July 1975 (photo taken from a TV screen).



A Review of Hypotheses



SINGLE GENETIC CODE

A genetic code that is common to all forms of life on earth, with the molecular configuration being determined by the amino acid content of proteins. This "alphabet of life" is in practice limited to twenty-six kinds of organic molecules. Many biologists consider it strange that there should be only one such code. If life arose spontaneously on our planet, then in all probability it originated in a number of places at different times, with living organisms possessing similar, but not identical codes.

Therefore the proposition has been advanced that life appeared on earth in the form of bacterial spores, brought here several geological eras ago from other planets, where it already existed. And from this the idea naturally arises that it must have been sent here by some kind of cosmic beings.

Is this the way it was? If only we knew!

A Review of Events

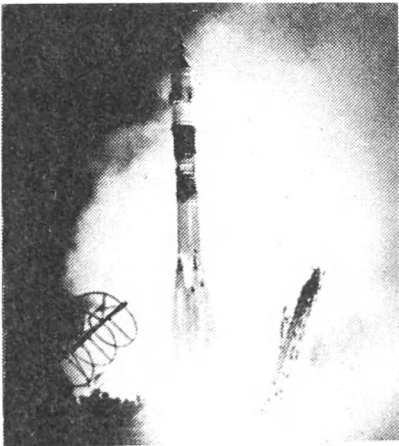
orbits over the equator in the region of the Indian Ocean in 1975, 1976 and 1978.

To achieve such an orbit from the launching site in the USSR requires a whole series of complicated manoeuvres in space, with a consequent large expenditure of fuel—more than that required for the flight from the earth to the moon.

The satellites, *Raduga*, *Ekran* and *Gorizont* which are fitted with special antennae, ensure greater reliability of communications over the territory of the Soviet Union.

SOYUZ-28

The transport spacecraft which, on 3 March, 1978, delivered to the orbital station, *Salyut-6*, the world's first international space crew—Alexei Gubarev (the commander, USSR) and Vladimir Remek (cosmonaut-researcher, Czechoslovakia). Having completed their eight-day programme, Gubarev and Remek returned to earth on 10 March.



American astronauts came to the Soviet Union on a two-week visit which included tours of several Soviet cities. The occasion was marked by the publication in local newspapers of reminiscences of veterans of the war—those who had taken part in the



The entire population of Sochi on the Black Sea coast turned out to welcome Soviet and American spacemen—Thomas Stafford, Alexei Leonov, Valeri Kubasov, Donald Slayton and Vance Brand—during the Americans' two-week visit to the Soviet Union in September and October 1975.

link-up with American forces on the Elbe in May, 1945—a war which resulted in the defeat of fascism.

When leaving Siberia, which had been included in the tour undertaken by the Americans, Vance Brand made this comment:

"In developing our continent, we Americans moved from East to West. You people, in developing Siberia, moved from West to East. But our flight showed, I would say, that we can both move in the same direction."

No less warm a welcome was given to the crew of the Soyuz-19 spaceship in Nashville, Tennessee.



There will be many more chapters to be written in the history of space exploration. Since this booklet was written, scientists have obtained further data on Venus, supplied by the Soviet probes *Venera-11* and *Venera-12*, and more satellites in a continuing series have been launched in the Soviet Union for communications, meteorology, solar research, to study the origin of X-ray radiation from outer space, and for many other purposes.

The aim of all this work is exclusively peaceful, for, as Leonid Brezhnev said, "In international affairs, the Soviet Union believes its most important task is to prevent mankind from drifting towards war, to uphold and strengthen peace—a universal, just and lasting peace."

Each book about the cosmos, big or small, only sums up what has been achieved under this or that programme, providing new and often unexpected information, opening the way to new interpretations of old discoveries. But man's thirst for knowledge is limitless, as infinite as the universe itself. And we have still very much to learn by space research.



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