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Space INTELLIGENCE NOTES

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THE USE OF TELEVISION IN SOVIET SPACE RESEARCH. The following is a translation of an article by Soviet engineer V. A. Sokolov which describes the project in which television pictures of the reverse side of the Moon were successfully taken and transmitted back to the Earth.

On 4 October 1959 a third cosmic rocket was successfully launched from the territory of the Soviet Union and sent to the region of the Moon. Its flight trajectory differed substantially from that of the two that had preceded it. The third cosmic rocket was to arrive near the Moon, curve around it, return to the vicinity of the Earth and transmit to our planet images of that part of the Moon's surface which cannot be observed from the Earth.

The cosmic rocket put an automatic interplanetary station into an orbit around the Moon; it did so for the purpose of scientific research and the transmission of images of the reverse side of the Moon. The station consists of an airtight container holding scientific apparatus and chemical power sources; certain scientific instruments, such as solar batteries and antennas, are outside the container. Included among the apparatus carried aboard the station are devices which make it possible to transmit images for distances of a hundred thousand kilometers.

How did such unusual television transmission in space come to pass? Before we answer this question, let's discuss the basic principles of ordinary terrestrial television.

As is well known, all television transmission is accomplished on the basis of the following principle: the image of the object is broken down into an immense number of individual elements with varying degree of brightness; information about the brightness of each of these elements is subsequently transmitted to a receiver.

If the image is projected onto the screen of a camera tube, electrical charges accumulate on each of the elements of the screen; the value of these charges is proportional to the illumination of these elements. The image on the screen of the camera tube is transformed from an optical to an electrical image. An electronic beam alternately travels swiftly over all the elements of the screen, forming lines thereon, one above the other, and removing the charges, sending them into an amplifier and then into the transmitter.

At the end of the radio link an electronic beam traces these same lines on the screen of a picture tube covered with a fluorescent material. The intensity of the beam and the resultant brightness of the fluorescence of the different points on the screen changes in proportion to the value of the charges of the corresponding elements of the camera tube. An image therefore appears on the screen of the picture tube.

The quality of an image is appraised by its definition, that is, the degree of clarity in the reproduction of small details. Definition can be expressed by the maximum number of èlements of which the image is composed. In the Soviet television system images are broken down into approximately 400,000 elements.

Another important index in television transmission is the time expended in the transmission of one frame. In Soviet television it is equal to 1/25 second.

Finally, the third index is the frequency band of the television signal.

The speed of change in the intensity of the scan-off beam can change in a wide range, depending on the form of the transmitted image. This is accomplished in such a way that there are no pairs of adjoining elements on the screen with identical charges. With the image broken down into 400,000 elements and the transmission time for one frame being 0.04 second, it is necessary for the beam to be able to change in intensity up to 5 million times a second. This means that the television channel should have an extremely great band width of 5 mc.

Let's return to the problems of cosmic television, to the transmission of images of the Moon's surface.

One of the most important characteristics of any radio link is its resistance to static, that is, its ability to carry transmissions properly, whatever be the interference. What is involved here is that other external electrical disturbances in addition to the useful signal arrive at the receiver; these make reception difficult and sometimes make it impossible. The sources of static are extremely varied: transmissions by other radio stations, an electric streetcar operating in the vicinity, radio signals of cosmic origin, a vacuum cleaner in use, a distant thunderstorm, the radioradiation from the Sun, and many others. Every electrical apparatus also has its own noises; these are due primarily to the chaotic thermal movement of electrons in different parts of the circuit, wires, etc.

The struggle against static involves the creation of such systems as will permit the reception of signals at the input of a receiving apparatus which have a power identical to or even less than the power of the static. This is achieved in a relatively easy and simple manner when we are dealing with ordinary terrestrial radio links; the problem is considerably more complex, however, when we deal with transmissions from space.

As is well known, the power of the transmitter aboard the automatic interplanetary station was calculated in watts. At the time of its flight the station could turn, changing its orientation in space and relative to the Earth; for the continual reception of its signals it was therefore necessary that the transmitting antennas have a circular form. For this reason the radio signals were transmitted equally in all directions and their power, with increasing distance from the station, decreased in proportion to the square of the distance. At distances of almost a half-million kilometers the power arriving on one square meter of the Earth's surface was 10^{-18} watts. In order to visualize how small this signal is, the following example may be given: if the transmitter of the automatic interplanetary station emitted a power equal to that of all the electric power stations of the world, the signal would still be several million times less in strength than the power needed to light the bulb of an ordinary pocket flashlight.

That is why the reception of signals from the automatic interplanetary station, in addition to very sensitive receiving devices and directional antennas, also required special methods for the processing and transmission of signals. This was true both at the station itself and on the Earth; in other words, a special static-resistant system had to be developed.

As is well known, static resistance can be increased by an increase in the power of the signal, the width of the transmission band, or an increase in its duration. Most circuits use one of these alternatives. It is clear that there can be no major increase in the power of the transmitter aboard the automatic interplanetary station. An increase in the band width is also infeasible. The latter is due to the reasons given below.

Such insignificant signals as travel from the station to the Earth can only be received by very sensitive receivers. The noise level at the output of the receiver depends to a high degree on the frequency band which it intensifies. If it is decreased by 10,000 times, for example, the noise level in the receiver itself will decrease by no less than 100 times. This means that it made sense to have a narrow-band transmission system in the automatic station, not a broad-band one.

The narrowing of the band, however, quickly leads to a decrease in the speed of transmission. Here is how this happens. Let's assume that the frequency band of our supposed television network is not 5 mc, but is 500 c instead -- that is, 10,000 times narrower. If it is required that the quality of the image (broken down into 400,000 elements) be stable, the time needed for the transmission of one frame should almost be a full 7 minutes -- not 0.04 seconds. Something similar applied in the case of the first cosmic rocket transmission. The use of special methods of processing, transmission and reception of signals could change only the degree of lowering of the speed of transmission.

But in a few minutes the automatic interplanetary station travels a hundred kilometers and no system of orientation can hold it all this time in a position in which the Moon's surface image will remain stable on the screen of the camera tube. It is clear that a quality image is simply impossible in such a case at the time of transmission to the Earth. The solution of this problem nevertheless appears obvious. It is necessary to photograph the Moon, process the film at the station, and transmit a fixed image to the Earth from the resulting negative. This method is also good in that it is possible to transmit the same frame several times and the transmission regime can be speeded up as the Earth is approached.

In order to photograph the reverse side of the Moon it was above all necessary to turn the automatic interplanetary station and the lenses of its cameras toward the Earth's surface at a fixed moment. At 0630 hours on 7 October 1959, when the station was situated at a distance of about 65,000 km from the Moon, the system of optical and gyroscopic units, complex electronic computers, and controlling motors accomplished this operation; subsequently they maintained the automatic interplanetary station in the necessary position for the entire period during which the Moon was photographed. Both lenses of the camera operated for 40 minutes, directed only at the Moon. During this time its reverse side was repeatedly photographed on a special 35 mm film at two different scales. After the exposure was completed the film entered a small device for automatic processing; there it was developed and fixed and then entered a casette for television transmission.

Over the command radio link from the Earth to the interplanetary station went the order: "Begin transmission!" The necessary power sources were switched on and the automatic system began to operate, resulting in the coordination of the operation of all the links of the television apparatus. The transmission began.

The transformation of the optical image of the Moon -- present on the film negative -- into a complex of electrical signals was accomplished by a system with a camera tube. Such an arrangement is called a scanning-beam system. The light source is a well-focused fluorescent spot on the screen of the scanning tube. By means of deflecting devices this spot moves along the screen in horizontal and vertical directions, tracing lines, one under the other, across the screen. The image of this fluorescent spot is projected by means of a lens onto the transmitted frame. The beam of light passing across the photo film is collected by an optical device -- a "collector" -- onto the photocathode of a photoelectron multiplier. Since the spot of light successively passes over and makes fluorescent the different parts of the frame, a television signal is received at the outlet of the photomultiplier; this signal changes in time, for the whole image.

A mixed system for scanning of the image was used in the television transmission from the automatic interplanetary station. The horizontal sweep was electronic, that is, it was accomplished by the electronic beam of the camera tube moving across the screen (this corresponded to the movement of the fluorescent spot across the frame).

The vertical sweep was mechanical. The film was continually drawn past the camera tube at a slow rate of speed. Mixed scanning was used because during the time of transmission, equal to several minutes, the mechanical system of slow drawing of the film is far simpler, reliable, and generally better than electronic vertical scanning.

The desire to get the most detailed possible photographs of that part of the Moon that is invisible from the Earth required that the photographs be made with the Moon's disk fully illuminated by the Sun. The absence of shadows due to head-on illumination led to a decrease in the contrast in the negative, that is, to a decrease in the transparencies of its dark and light places. In order to correct this inadequacy of the negative, its contrast was artificially increased by the use of changes in the brightness of the spot in the camera tube of the phototelevision apparatus. The signal, thus corrected, arrived at the input of the narrow-band amplifier from the photoelectron amplifier and after certain transformations was sent out into space by the transmitter's antennas.

The signals, after reception and amplification, were recorded by apparatus of various types. Among them were special devices for the recording of television images directly on a film. The received signals control the brightness of its spot; the latter is focussed on the film by means of an optical system. The spot on the picture tube duplicates the motion of the spot on the camera tube; the film in the Earth-based apparatus moves at the same speed as on the automatic interplanetary station. Thus, the entire transmitted frame is "traced" on the film.

The relatively narrow band of the receiver television signal made it possible to a greater degree to magnetically record the signals. The signals of the image are recorded on a continually moving ferromagnetic film. As a result the film forms a recording which is magnetized differently in its several parts.

One of the varieties of electron-beam picture tubes used was the skiatron tube. In contrast to ordinary picture tubes the skiatron screen is covered with a substance (usually ion salts of silver chloride) that has the property, after bombardment with electrons, of taking on a capacity (on a long-term basis) of not radiating light as we are accustomed to, but of absorbing it. Under normal conditions the skiatron screen is quite transparent before reception begins. But when the electron beam has run across it, those places where it makes contact then become dark; the degree of darkening depends on the intensity of the beam at the moment of contact. The capacity of holding the received image for a long time is a peculiarity of the skiatron tube. The received image can be easily photographed directly from the screen, and in case of necessity it can even be projected onto a larger screen like an ordinary diapostitve.

The use of special methods of recording has made it possible in the future, when comparing images received by the different methods, to eliminate or correct the specific mistakes inherent in each of them individually.

Thus was accomplished history's first television transmission from outer space. The unique photographs received of the reverse side of the Moon made it possible to make the first lunar globe. The transmission of images for a distance of 400,000 km confirmed the possibility of a quality television transmission from the outer reaches of space. This opens up immense vistas for the further study of the planets of our solar system and interplanetary space.

("Photo from Space", by Eng. V. A. Sokolov, Nauka i Zhizn', No. 3, 1960, pp. 8-10.)

A CLIMATE-CHANGING "SATURN RING" FOR THE EARTH. Valentin Barisovich Cherenkov has proposed a method of creating heat and light by creating a ring of small particles around the Earth which would capture some of the Sun's energy now lost to us.

According to Cherenkov's plan a belt of particles averaging 0.3 microns in diameter, 100 kilometers wide and 1,000 to 1,500 kilometers above the Earth between 70 to 90 degrees north latitude would be sufficient to change the climate of the Northern hemisphere.

A plan forwarded by M. Grodskiy consists of creating a belt of potassium particles with a lower altitude of 1,200, and an upper altitude of 10,000 kilometers and a total weight of 1,750,000 tons. This material would be carried aloft by rockets and dispersed by a special centrifugal apparatus. The effect of the reflecting belt would be to reflect to the Earth a greater part of the one two-billionths of the Sun's energy which it now receives, greatly improving the thermal system of the northern hemisphere, improving navigation of the North Sea routes and northern rivers, and would have no appreciable effect upon the tropical latitudes.

"STRELKA" AND "BELKA" IN SATELLITE ORBIT. In conformance with the plans for study of cosmic space, the second space ship was placed into an Earth-satellite orbit from the Soviet Union on 19 August 1960. The main task of the launching is the further development of systems which will ensure the vital activity of man, and will ensure his flight and return to Earth.

The cabin, which is equipped with all the essentials for the future flight of man, contains pre-experimental animals, including two dogs, named "Strelka" and "Belka".

During the flight of the space ship-satellite many medicobiological experiments are to be conducted and the program of scientific investigation of cosmic space is to be carried out.

The second Soviet space ship-satellite is in an orbit closely approximating a circle, with an altitude of approximately 320 kilometers.

The initial period of revolution of the space ship is 90.6 minutes, and the angle of inclination of its orbit from the equatorial plane is 65 degrees. The weight of the space ship-satellite without the last stage of the carrier-rocket is 4,600 kilograms.

The space ship-satellite carries a "Signal" radio transmitter operating at 19.995 megacycles, radio telemetering equipment for transmitting to the Earth data on the status of the pre-experimental animals and on all the systems installed on board the satellite.

A radio television system has been installed on board the space ship-satellite for observation of the behavior of the animals.

According to the initial results of processing of the telemetric data transmitted from the space ship-satellite, the equipment installed on board is functioning normally. The transmissions of the "Signal" transmitter installed aboard the satellite are being positively received at numerous points.

The pressure, temperature, composition and humidity of the air in the cabin are maintained within the limits of established norms. During the entire period of orbiting the air temperature in the cabin has been maintained at approximately 20 degrees Centigrade and 760 mm pressure.

The telemetric measurements of physiological parameters characterizing the status of the animals indicate that they satisfactorily survived the period of launching and entering into orbit of the space ship-satellite. The pulse of the dog "Strelka" prior to launching was 90, and frequency of respiration was 60. During the period of entry into orbit its pulse rose to 160 and respiration rose to 125. After one and one-half hours its pulse was 65 and respiration 24.

The pulse rate of the dog "Belka" before launching was 75, and respiration rate was 24. During the period of entry into orbit its pulse rose to 150 and its respiration rose to 240. After one and one-half hours its pulse rate was 72 and its respiration rate was 12.

The data indicate that during flight in orbit under conditions of weightlessness the physiological functions of animals are normalized. Images of the animals, also indicating normalization of physiological functions, are received through the television system. The taking of food by the animals is also registered.

On the basis of measurement of the elements of its orbit the space ship-satellite has the following values: period of revolution 90.7 minutes, altitude of perigee 306 kilometers, altitude of apogee 340 kilometers, and inclination of orbit from the equatorial plane 64 degrees 57 minutes. (Pravda, 20 Aug. 1960.)

IMPORTANT BOOK "BY ROCKET TO THE MOON" PUBLISHED IN USSR. V. I. Levantovskiy is the author of a significant 379 page book entitled "By Rocket to the Moon" (Raketoy K lune), published in 1960 by the State Publishing House for Physical-Mathematical Literature in Moscow. The attractive book was printed in 15,000 copies and sells for 9 rubles 45 kopecks. There are 146 splendid diagrams and photographs, plus many additional plates.

The book discusses a variety of problems associated with flights to the Moon and also the principle theoretical problems that are of general importance in astronautics.

After setting forth the principles of rocket technology and the elements of celestial mechanics necessary for comprehending the laws of motion of rockets in outer space, the author makes a detailed examination of the various classes of trajectories for flight to the Moon (hitting the Moon, flying around the Moon, etc.); methods for launching artificial satellites of the Moon and their possible orbits; flight from the Earth and landing on the Moon; flight from the Moon and landing on the Earth; outlook for the development of rocket technology and the use of interplanetary stations; the possibilities of automatic rockets and problems of penetration by man into outer space; outlook for the use of atomic and solar energy in rocket motors; unusual trajectories; advantages and disadvantages of so-called rockets with continual thrust (ion, plasma, etc.); secrets of the Moon and astronautical methods for exploration of the same; flights to Venus and Mars and the use of artificial planets--this is by far an incomplete listing of the problems discussed in the book.

The book extensively treats problems associated with the historic flights of the first three cosmic rockets and gives details concerning the launching of the American cosmic rockets.

The book is written in popular form, but at the same time it requires attentive and thoughtful reading. It will be of interest to all who are seriously interested in the principles of astronautics as a science and in the past attainments and future outlook in the field of space mastery. ("By Rocket to the Moon", V. I. Levantovskiy, State Publishing House for Physical Mathematical Literature, Moscow, 1960).

LIFE ON MARS. The following excerpts from the Ukrainian-language periodical Znannya ta Pratsya (Knowledge and Work), describe some interesting discoveries and resulting theories on the composition of the Martian surface.

It is interesting to follow through a telescope the changes in the coloring of the planet depending on the season.... Such phenomena have given us reason to believe that the dark colorings are signs of plant life....

In 1956 Sinton made the first spectographic analysis of Mars, using the Harvard Observatory telescope... In November 1958, Sinton repeated his experiment at Palomar Observatory. This gave Sinton and others scientists reason to conclude that life exists on Mars....

Our photos bring out the dynamics of changes of one of the areas of Mars near the so called Cimmerian Sea from 1909 to 1958. We can see here certain changes in that segment such as the creation of new "canals".

In 1956 the well-known Soviet geophysicist Professor Lebidenskiy stated that water vapor does not exist in the atmosphere of Mars, regardless of the presence of moisture on that planet. Hence it is quite probable that the water there is in the form of underground ice and that the amount is certainly quite great.

There is reason to assume that during "marsquakes" (by analogy with earthquakes) the intactness of the ice cover is destroyed; fissures appear through which water bubbles; at first the water evaporates into the atmosphere and later condenses. The nature of this phenomenon can apparently be explained by the mysterious streaks along the canals mentioned by Academician Baraboshov as early as 1924. Such an extensive icy hydrosphere also explains the absence of high mountain areas.

Along the cracks in the ice cover climatic conditions must be very mild, and if this is so there may be vegetation which observed at a great distance may appear as regular solid lines. ("Life on Mars," Znannya ta Pratsya, No. 6, 1960, p 19)

U-2 REACTION. World-wide repercussions to the U-2 flights over Russia are becoming more apparent. Certain foreign nationalist feeling has already resulted in making the tracking of our satellites more difficult. Some Courier communication satellite stations in Africa and a satellite-reporting station in Pakistan have been canceled. Mexico is agitating, and Nigeria and Zanzibar are holding out on acceptance of Mercury space-vehicle tracking stations. Orbits for Air Force Samos reconnaissance and Midas early-warning satellites, both experimental as yet, are expected to be changed to avoid over-flying Soviet territory. Our perimeter defense and quick retaliatory power for local outbreaks are threatened by possible reductions of overseas bases. Increasing Communist threats and Red encouragement of nationalistic ferror make our overseas tenancies uncertain.