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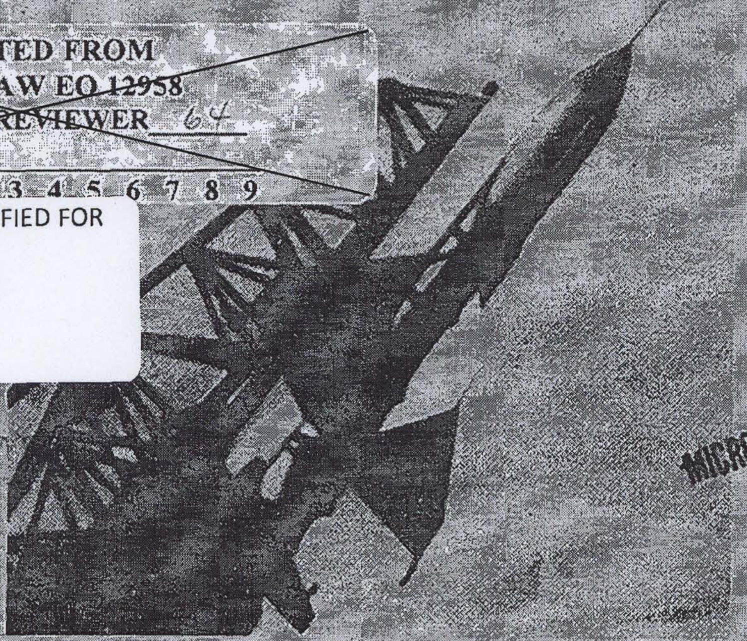

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Issue No. 51/65, 17 December 1965

The WIR in Brief

COVER: GRIFFON antimissile-missile on launcher (from Red Star) (OFFICIAL USE ONLY)

NOTE: Pages 34, 36, 37, 40, 41, and 42 of this issue are blank.

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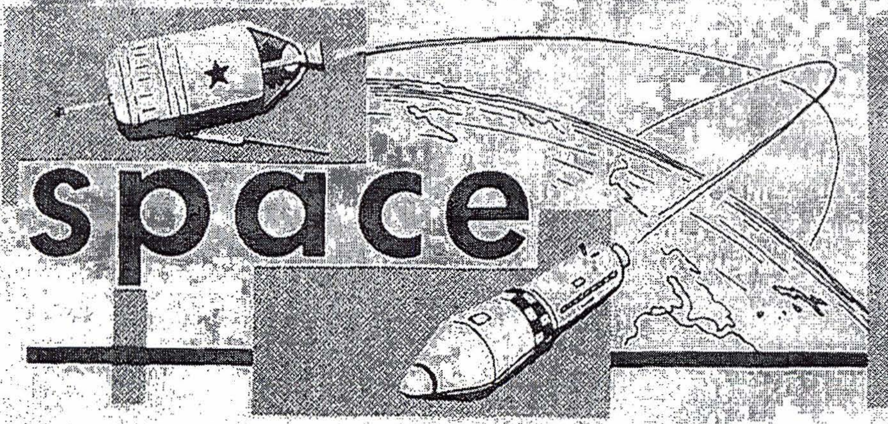

significant intelligence on space developments and trends

Some Results of Proton-1 Satellite Experiments Reported in Pravda

A NORAD translation of an article in the 16 November issue of Pravda. (Parenthetical remarks are NORAD's.)

The heavy space station Proton 2 was orbited on 2 November 1965. Thus was taken the next very important step in the execution of the broad program of research begun by Proton 1.

In every area of science, at each stage, there is a series of key questions, the solution of which will permit significant advancement in our knowledge of nature and in the development of a given field of knowledge. Thus, in the physics of elementary particles, one of the important questions is: what happens when protons and atomic nuclei collide, at various energies of the colliding particles?

Astronomers have observed a great number of astronomical objects which are powerful sources of radiowave energy. It has been conjectured that these waves are associated with electrons which possess energies of billions of electronvolts or more. In order to confirm the correctness of this hypothesis, which is most important for radio-astronomers, these electrons must be observed directly in space and their energies measured.

In cosmic-ray particle physics one of the key questions concerns their origin, that is, how do the atomic nuclei of various elements acquire their enormous energies? Some cosmic-ray particles have energies of 10^{18} (1,000,000,000,000,000,000) electronvolts. In order to approach the question of the origin of cosmic rays, a detailed study of their nature must be made and those places in the Galaxy where they are born must be located.

Cosmic-ray particles which enter the atmosphere collide with atomic nuclei of the atmosphere, forming secondary particles of various types and energies. When the primary particles have very high energies, then the collisions form an enormous number of secondary particles -- hundreds of thousands and millions of them falling in an area of a few hectares (1 hectare equals 2.47 acres). These streams of particles are called broad atmospheric cosmic ray "showers".

To explain how these processes occur, the manner in which primary cosmic-ray particles create these phenomena must be studied, that is, they must be sorted by the magnitude of their energies -- the energy spectrum of the particles -- and by the magnitude of their electrical charge; that is, their chemical composition must be determined. These and a series of other key problems can be solved with the help of cosmic- ray research.

Although scientists began long ago to clarify the role of cosmic rays in the study of fundamental phenomena of nature, they were unable until recently to utilize the full potential power of this type of research in various areas of science. The fact is that conducting suitable experiments under terrestrial conditions is time-consuming, sometimes taking years. This time can be cut significantly if the experiments can be carried out either at very great altitudes in the atmosphere, or beyond its limits, using multiton apparatus.

Our country, which inaugurated the space era, has now created the world's most powerful rocket carrier. This rocket was used to inject in near-Earth orbits on 16 July and 2 November the heaviest payloads ever used in the exploration of space. As is known, the total useful payload of Proton 2, as with Proton 1, including the control and tracking gear, was about 12.2 tons. The ability to inject a useful payload of such enormous weight into near-Earth orbit is opening unprecedented prospects for the study and exploration of space.

The scientific space stations Protons 1 and 2 were intended to make a manifold study of cosmic rays, with a view to obtaining answers to a series of questions of the physics of elementary particles, astrophysics, physics of the Sun, cosmic-ray physics, and also the techniques of space flight.

In order to solve numerous scientific problems, including a study of the particles of cosmic rays of high and superhigh energies, Protons 1 and 2 were fitted out with a unique device -- the ionization calorimeter, which was conceived and built by Soviet physicists.

This device is used to study the energy spectrum -- that is, the distribution of energy -- of primary cosmic-ray particles in the energy region of 10 to 100,000 billion electronvolts and the chemical composition of primary cosmic rays in this energy region. This same device permits studies of the processes which occur when protons collide with atomic nuclei, where the energies of the particles range from tens to thousands of billions of electronvolts, giving birth to secondary particles. Such collisions are called inelastic.

For studying high-energy electrons, an instrument called the

SEZ-12 was developed. This complex and relatively heavy device uses modern methods of nuclear physics to separate elementary particles according to mass.

A charge spectrometer, the SEZ-1, is used for studying cosmic rays with energies below 30 billion electronvolts, including those which sometimes issue from the Sun. The essential difference between this and analogous instruments, and in particular those used earlier by Soviet physicists on spaceships and space rockets, is its large "illumination" -- that is, sensitivity over a wide band of the cosmic-ray-particle region. This band includes the atomic nuclei of elements from hydrogen to tin, that is, almost half of the elements existing in nature. Thanks to the great sensitivity of this instrument, it can reliably register small changes in the intensity of cosmic rays associated with solar activity.

Special gamma-telescopes (the GG-1) were installed on Protons 1 and 2 for research of electromagnetic radiation of high energy -- gamma-quanta. These devices were intended to obtain "photographs" of the sky, but not in the usual sense of the term -- visible light -- but in a region where the waves are hundreds of millions of times shorter. Such photography makes it possible to clarify the question of the degree to which cosmic rays and interstellar substance in the Galaxy are distributed equally.

All these instruments were so designed as to form a single complex, which is shown in Figure 1 (page 35). This set of scientific apparatus was installed inside the space station Proton.

We shall cite a few figures to indicate the scale of the experiment and the complexity of the scientific apparatus. Proton 1's apparatus registered more than 180 parameters. The electronic pack of the apparatus contained more than 4,100 transistors and more than 4,500 crystal diodes, about some 9,000 semiconductor elements in all.

The scientific apparatus passed with honors the severe test on Proton 1. An enormous amount of information was obtained for all parameters.

This information, received in an unbroken stream by the numerous scientific devices, were "memorized" by special devices aboard and periodically, on command, were transmitted to Earth.

Every link and every system of the whole had to have exceptional reliability in order that the complex onboard apparatus would provide consistent working of the space-station systems throughout the flight.

The weight of this grandiose set of rocket-technology and scientific apparatus concentrated in Proton 1 made it possible to obtain a series of extremely interesting data.

Of great interest, as always, were the unexpected results -- those which yielded new information and which represented building blocks in the continually mounting and developing edifice of science.

A preliminary analysis of the energy spectrum of primary cosmic rays, according to data obtained by Proton 1, shows that the previous picture, which had been built up on the basis of indirect data, is not confirmed by direct, immediate measurement. Figure 2 (page 35), depicts a graphic representation of these results. On the horizontal axis energies of cosmic-ray particles are plotted on a logarithmic scale; on the vertical axis the flux of these particles is plotted, also on a logarithmic scale. The triangles show the measurements made by one ionization calorimeter, the small circles show the measurements made by the other one. The crosses show the measurements of the spectrum of primary protons.

What can we say about these measurements?

In the first place, their uniqueness consists in the fact that they were obtained beyond the atmosphere; they represent the energy of primary particles of high and superhigh energies falling directly on the measuring devices.

Secondly, a single instrument has for the first time made measurements of particles which differ in energy by a factor of almost 10,000.

Thirdly, the energy spectrum of protons -- curve No. 2 -- and the energy spectrum of all particles -- protons and atomic nuclei of other chemical elements, curve No. 1 -- parallel. It follows from this that at least in the energy band 10^{10}-10^{12} (10 billion to 1 trillion) electronvolts the proportion of heavy nuclei of primary cosmic rays to protons remains constant.

Fourthly, the intensity of particles of high and superhigh energies, as measured by direct methods by Proton 1, turned out to be essentially less than had been determined by the study of broad atmospheric showers under terrestrial conditions -- the little 4-sided figures in Figure 2.

These results are of important scientific significance. They can lead to a revision of the notions as to how secondary high-energy cosmic particles are formed when primary cosmic rays collide with atomic nuclei, including those of the atmosphere, and can also lead to new notions about how broad atmospheric showers are formed. The essential differences between the direct and indirect measurements in the physics of broad atmospheric showers must also be clarified.

Experiments conducted by Proton 1 have supplied experimental verification of very important predictions of theory -- by measuring the dependence of the probability of inelastic collisions of protons with atomic nuclei of carbon at various proton energies. Measurements were made in the energy region of 10 to 1,000 billion electron volts. The results are shown in Figure 3 (page 35), on which the proton energies are plotted on the horizontal axis, the magnitude of effective section on the vertical axis. The "effective section" is a magnitude characterizing the probability of interaction of microparticles -- molecules, atoms, atomic nuclei. It is a measurement of area, expressed in barns (1 barn equals 10^{-24} square centimeters per nucleus).

The little circles show the measurements carried out with one ionization calorimeter, the squares the measurements made by a second ionization calorimeter. The crosses signify the results obtained by the most powerful modern accelerators. The points indicate the significance of effective section if it did not depend on the energy of the colliding protons.

The fine vertical lines indicate the magnitude of the error of measurement. These results, obtained for the first time, have very great significance for the physics of high-energy particles. This is that the magnitude of effective section turns out to be dependent on energy approximately as predicted by theory; this is an extremely important fact for the theory of elementary particles.

Remarkable among the measurements is the fact that in the energy region already studied in detail -- 10^{10} to $3x10^{10}$ (10 to 30 billion) electronvolts -- the results obtained by Proton 1 coincide well with the measurements carried out by powerful accelerators of various nations.

The measurement of high-energy electrons beyond the atmosphere by Proton 1 was the first experiment of this type. An unexpectedly great flux of electrons with energies of more than 300 million electrons volts was observed. It turned out to be almost equally intense at every point in near-Earth space, excepting the polar regions, which the space station did not cover. The intensity was almost 10 times as great as would be expected from measurements of high-energy electrons previously made in the stratosphere.

The independence of the intensity of electrons of the latitude of the place of observation indicates that almost all of them are of secondary origin and are not electrons of Galactic origin. However, the mechanism of formation of such an intense stream of secondary electrons of high energy beyond the limits of the atmosphere remains unclear.

It is not possible in a newspaper article to dwell on other extremely interesting results obtained during the flight of Proton 1. We have noted only certain of those results which were obtained for the first time. That is why multiple verification and confirmation of experimental data obtained is extremely important. The launch of the space station Proton 2 will enable the continuation and development of these important studies.

Thanks to them it will be possible, in the first place, to determine the effective section of inelastic collision of protons with atomic nuclei in the high-energy region. Secondly, it is especially important, in the light of the results already obtained, to measure the effective section of inelastic collision of protons with protons in the energy region of 10^{10} (10 billion) electronvolts and higher.

In addition, the study of primary cosmic rays of superhigh energies will be continued.

Certain control experiments will be conducted on Proton 2, along with studies of high-energy electrons. The accumulation of data about the luminosity of the sky in the gamma-ray region will be continued.

The launch of Proton 2 is a great scientific-technical achievement. The creation of unique scientific space-rocket equipments lays the basis for the conduct of researches, heretofore impossible, of an enormous circle of physical phenomena -- from processes of the microworld to gigantic processes of galactic and even metagalactic scale.

N. Grigorov, I. Savenko, G. Skuridin

(Pravda)

NORAD Comment: A Soviet description of instrumentation aboard carried by Proton 1 was published in WIR 34/65, 20 Aug 1965.
(NORAD)
(UNCLASSIFIED)

17th Soviet Photorecce Satellite of 1965 Launched

The Soviets launched Cosmos 99 from Tyuratam at about 0810Z, 10 December 1965. This satellite is their 17th photoreconnaissance satellite of 1965, 5 more than the 12 launched last year. Orbital parameters of Cosmos 99 have been announced as follows:

	By NORAD Space Defense Center	By TASS
Inclination	65.06 degrees	65 degrees
Period	89.89 minutes	89.6 minutes
Apogee	359.87 km (193 n.m.)	320.4 km (173 n.m.)
Perigee	196.22 km (106 n.m.)	199.3 km (107.6 n.m.)

Cosmos 99 was launched by the SS-6 ICBM booster-sustainer and injected into orbit by the Lunik upper stage, the use of which generally signifies that a camera system of median resolution (20 - 30 feet) is carried. Unexpectedly, this is the second Soviet photorecce vehicle to be injected by the light Lunik upper stage. Earlier this year it was used on alternate photorecce satellites, and later the heavy Venik stage was used for 5 consecutive launches.

Launch occurred at about the same time as the 4 preceding Soviet photorecce launches, but somewhat earlier than the average; photorecce satellites usually have been launched between 0930Z ant 1100Z.
(NORAD; TASS)
(~~SECRET~~ NO FOREIGN DISSEMINATION -- Releasable to US, UK & Canada)

Scientific Instrumentation of 'Proton' Satellites

(Other Proton photos and drawings were shown in WIRs 33/65 & 34/65, but this is the first to give some impression of the size.)

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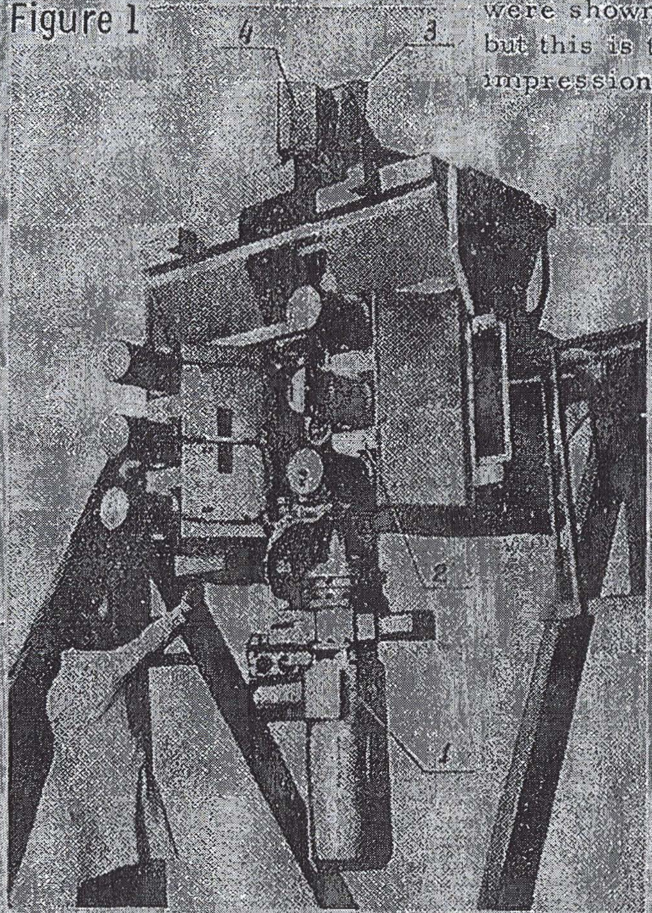
WIR 51/65
17 Dec 65

Figure 1



1. Electron spectrometer (SEZ-12)
2. Ionization calorimeter
3. Gamma-telescope (GG-1)
4. Low-energy-particle charge spectrometer (SEZ-1)

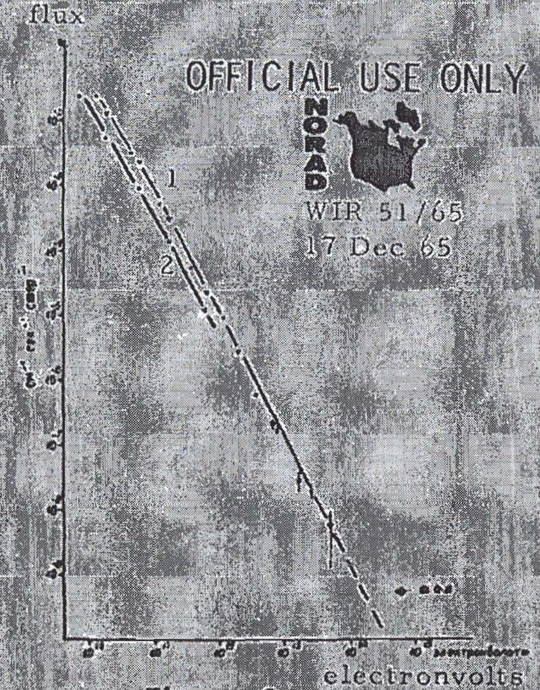
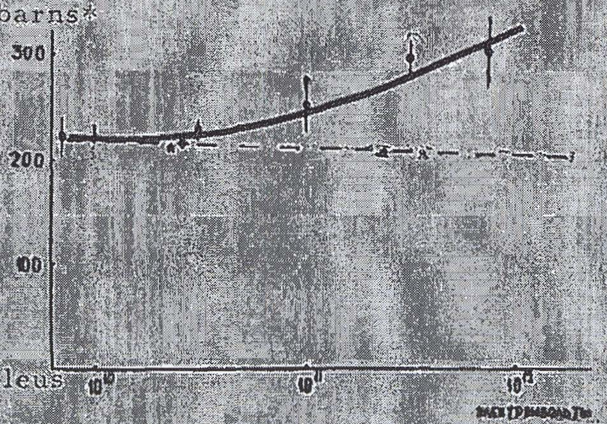


Figure 2



*1 barn equals 10^{-24} cm^2/nucleus

Figure 3

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