

Space

INTELLIGENCE NOTES

SPACE SYSTEMS INFORMATION BRANCH, GEORGE C. MARSHALL SPACE FLIGHT CENTER

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FROM THE WORLD PRESS

Page

- ◆ ANOTHER CUBA 2
- ◆ SOVIET ASTRONOMER DESCRIBES REASON FOR SUNSPOTS 3
- ◆ SATURN PROGRAM QUESTIONED 5
- ◆ INDIAN NARCOTIC MAY BE USED ON U.S. SPACEMEN 5
- ◆ THE SOVIET MARS 1 5
- ◆ US AND USSR TO COOPERATE ON THREE SPACE PROJECTS 6
- ◆ SOVIET PARACHUTIST JUMPS 24.1 KM (15 MILES) 7
- ◆ WILL COSMONAUTS FLY AGAIN? 7
- ◆ ROCKETS SAVE GRAPES 7

FROM THE SEMITECHNICAL LITERATURE

- ◆ SOVIET SPACE "EYE" IS LARGEST IN EXISTENCE 8
- ◆ "LIVING FOSSIL" ALGAE FOUND 10
- ◆ EAST GERMANY HAS WORLD'S BIGGEST TELESCOPE - 200 CM (78.7 IN.) IN DIAMETER 11
- ◆ A ROYAL AIR FORCE SPACE PATROLLER 13

FROM THE TECHNICAL LITERATURE

- ASTRONOMY
 - ◆ OXYGEN REPORTED ON VENUS 18
 - ◆ PHOTOGRAPHS TAKEN OF MARS 1 19
- ASTROPHYSICS
 - ◆ SPATIAL PERCEPTION AND ORIENTATION STUDIED BY RUSSIANS 19
 - ◆ HUNGARY COSMIC RADIATION RESEARCH 20
- BIOPHYSICS
 - ◆ COMPARING DIRECT AND INDIRECT ACTION OF IONIZING RADIATION ON DNA 21
- LIFE SUPPORT
 - ◆ SPACECRAFT METEORITE PROTECTION 25
 - ◆ SOVIET ARTIFICIAL ENVIRONMENT IDEAS DESCRIBED 25
- PHYSICS
 - ◆ RUSSIANS SOLVE PROBLEM OF THE MOTION OF A STABILIZED GYROSCOPE IN A CARDAN SUSPENSION 26
- RADIO COMMUNICATIONS
 - ◆ RADIO WAVELENGTH FORECASTING 27
- SPACE FLIGHT
 - ◆ MARS 1 DESCRIBED 27
- SPACE MEDICINE
 - ◆ SOVIET BIOMEDICAL RESEARCH ON SPACECRAFT 27
 - ◆ ANTIRADIATION DRUGS 29
- SUPPORT SYSTEMS
 - ◆ RUSSIAN LUNAR LANDING PLANS 29

BOOKS

- ◆ NEUTRON TISSUE DOSE 29
- ◆ HANDBOOK ON NUCLEAR PHYSICAL CONSTANTS TO EXPEDITE NUCLEAR REACTOR CALCULATIONS 30

BIBLIOGRAPHIES 30

FROM THE WORLD PRESS

ANOTHER CUBA. It has been reported that Cuba has not been the only place Russia has placed missiles on foreign soil. A Beirut correspondent has reported that Soviet missiles are presently being placed in Iraq.

The plan began in October of 1961 when an Iraqi military commission, headed by General Mahmoud Awkati, visited Moscow. Official sources never released details on the purpose of the visit, but there were strong indications that General Abdul Karim Kassem wanted military aid from the Kremlin.

General Awkati's mission was not easy, for the Soviets were not willing to provide arms on a no-strings-attached basis, according to the report.

Last spring a Soviet military commission, loaded with missile experts, visited Mesopotamia and looked over suitable missile sites. Construction of the launching pads has already begun, about 50 miles from Bagdad, in the desert. Soviet technicians numbering from 100 to 150, are working in the area. The Soviets plan to have several hundred rockets ready by 1963.

The rockets pose a great threat to Turkey and Iran. A very important NATO base at Adana in Turkey is only 480 miles away. When the pads are completed, Adana will be exposed to attack.

Although Teheran of Iran has promised not to allow American missiles to be placed within the country, many of the pads built in Iraq are aimed in that direction.

The agreements between Moscow and Bagdad indicate the weakness of the Kassem regime. With the arrival of Soviet troops and the construction of Soviet bases on Iraqi soil, pro-Communists around Kassem have been elevated to positions of greater importance. It cannot be long before they become strong enough to govern Iraq's domestic policy. (Source: In-telligence Digest, November, 1962)

SOVIET ASTRONOMER DESCRIBES REASON FOR SUNSPOTS. A Soviet astronomer believes he has discovered at least in part how bubbles of fire erupt on the Sun, thus releasing energy equivalent to that of many hydrogen bombs.

The energy of such a solar flare is, in fact, equal to the entire output of the Sun for many minutes.

Dr. Andrei B. Severny believes that convulsion is brought about by a release of accumulated magnetic energy. This is converted to heat that, he has proposed, is sufficient to initiate a thermonuclear reaction. This is the fusion reaction of the hydrogen bomb.

Dr. Severny is one of the Soviet Union's best-known astronomers. He heads the Crimean Astrophysical Observatory whose 259 cm (102-inch) telescope is the largest outside of California.

If he is right, his discovery is an important step toward understanding what produces flares. This, in turn, might ultimately make it possible to predict them, thus ameliorating the chief external hazard in space travel.

These outbursts occasionally shoot out particles of such high energy that they can pierce any spaceship. Inhabitants of the Earth are shielded effectively by the atmosphere, but anyone who encountered such a particle shower in space would be subject to a serious, and perhaps fatal, radiation dose.

The slower-moving gas ejected by a flare reaches the Earth a day or so later. It is this that produces magnetic storms, auroral displays, radio blackouts and other disturbances.

Dr. Severny's interpretation of flares derives primarily from his observations of changes in the strong magnetic fields that exist in the vicinity of such outbursts. His work is based on a technique developed at Mount Wilson, in California, by Dr. Horace B. Babcock. The latter is now assistant director of the Mount Wilson-Mount Palomar Observatories.

Dr. Robert Wilson, who has worked with Dr. Babcock, visited Moscow and says that he had been "almost rude" in his insistence on seeing Dr. Severny's original data and on talking with the man who actually made the observations. As a result, he now is persuaded that the magnetic changes occur.

The Severny observations strengthen the view that magnetic phenomena play some central role in the "life processes" of our parent star. Perhaps the most perplexing feature of these processes is the Sun's 22-year magnetic pulse, with all of its side effects.

It has long been known that the number of sunspots varies in a cycle that reaches its maximum about every 11 years. However, this cycle is far from simple. For example, the areas where spots appear migrate from mid-latitudes, north and south, toward the Sun's equator until sunspot minimum. They then suddenly begin to show up at high latitudes again to recommence this migration.

The magnetic polarization of the spots does a peculiar flip-flop. The first step toward a method of observing the Sun's magnetism was in 1908, when George Ellery Hale, at Mount Wilson, discovered that the lines in the spectrums of light from sunspots were split in a way that indicated strong magnetic fields.

The observation of the so-called Zeeman effect opened the way for the Babcocks to develop a method for magnetic mapping of the Sun. This has led to the discovery that, at each sunspot maximum, the polarity of the Sun does a somersault. Its north pole, magnetically speaking, becomes its south pole and vice versa.

At the same time, the polarity of sunspot pairs switches (sunspots often appear in pairs with opposite polarity). Thus, during one 11-year cycle, the eastern spots of pairs in the northern hemisphere will have north polarity, whereas eastern spots in the southern hemisphere will have south polarity. During the next cycle the situation is reversed.

The Sun therefore repeats its magnetic pattern once every 22 years rather than every 11 years.

One of the most surprising observations of this magnetic pulse was made from Mount Wilson in 1957, close to the sunspot maximum. The Sun's south pole became positive, but its north pole did not reverse polarity until the next year. During the interim the Sun had two positive poles.

According to Dr. Howard, the sunspot maximums in the Sun's two hemispheres were correspondingly symmetrical. That is, the maximum in the southern hemisphere was reached several months earlier than in the northern hemisphere.

Presumably these cycles are manifestations of processes deep within the Sun, but what they are no one knows.

A salient feature of Dr. Severny's theory is that flares occur where the magnetic fields of neighboring sunspots cancel each other out. In these magnetic "null" points, he says, the plasma, or very hot gas, is unstable and hence the spilling of pent-up magnetic energy is most likely. (Source: New York Times, December 2, 1962)

SATURN PROGRAM QUESTIONED. Some members of Congress are beginning to criticize the practicality of the Saturn program and the more than \$700,000,000 already invested in developing the Saturn booster.

The point bothering most of the critics is that thus far they think specific space missions have not been set down which justify the enormous expenditure. Representative Joseph E. Karth has stated, "this doesn't appear to be the best way to use a vehicle on which we have spent so much money." He feels we should be "speeding up the interplanetary research program, which may not be ambitious enough in scope and size."

Congressional critics think it would be profitable to use the Saturn for some of the flights scheduled for the Centaur. They argue that it will be operational just as soon and have far greater lifting power. (Source: The New York Times, November 14, 1962)

INDIAN NARCOTIC MAY BE USED ON U.S. SPACEMEN. Dr. John D. Reed of the National Aeronautics and Space Administration announced on November 23, while in Mexico City, that narcotics might be used to help choose the first American to reach the Moon.

Dr. Reed said that one problem in training astronauts was that they know the simulated emergencies they go through are not dangerous.

"We have been considering the use of hallucination-producing drugs to make a trainee feel a simulated flight is the real thing," stated Reed.

One of the drugs being tested is obtained from a narcotic mushroom used in ritual observances by Mexican Indians. (Source: New York Times, November 24, 1962)

THE SOVIET MARS 1. On November 1 the Soviet Union launched a one ton spacecraft toward Mars. Tass reported on November 2 that "all systems are functioning normally and orders sent to the station are well received and obeyed."

The probe is supposed to pass Mars at a range of from 966 km (600 miles) to 11,265 km (7,000 miles) next June, take photographs, and radio them back to Earth.

A "precise system of star orientation and special engines" are planned to give mid-course correction to the probe. By the time Mars 1 reaches its destination, it will be more than 241,000,000 km (150,000,000 miles) from the Earth.

It should be noted that all the reports received so far on "Mars 1" have been from Soviet sources. The Jodrell Bank Radio Astronomy Station reported on November 6 that "We have tried several times to pick up signals from the rocket but this is very difficult to do in the absence of the information we requested several days ago." Jodrell Bank had requested that they be given the broadcast frequencies of the probe so they might trace it. Without the frequencies they were forced to scan for long periods of time finding nothing.

The latest report on Mars 1 on December 5, from the Soviet news agency Tass, tells that the space probe is still functioning properly. Latest calculations show that it will bypass Mars at 193,000 km (120,000 miles). (Source: The Salisbury Times, November 2, 1962; The Washington Post, November 3, 1962; New York Times, November 7, 1962; Washington Star, December 6, 1962)

US AND USSR TO COOPERATE ON THREE SPACE PROJECTS. The United States and Russia told the United Nations on December 6 that they will work together on three big space projects: communications, weather-spotting and mapping the Earth's magnetic field.

The agreement stemmed from an exchange of messages between President John F. Kennedy and Soviet Premier Nikita Khrushchev. This came just after astronaut John H. Glenn's 3-orbit space flight last February.

The joint announcement was made to the U. N. General Assembly's main political committee by US Ambassador Adlai E. Stevenson and his Soviet counterpart, Platon D. Morozov.

No provision was made for cooperation on manned space missions, as Kennedy originally proposed, but officials have expressed hope this can be worked out too.

Under the agreement, the United States and Russia will:

1. Cooperate in space communications, eventually using US satellites of the repeater type that pick up signals from the ground, amplify them and beam them back to other parts of the world.
2. Make coordinated launchings of weather observation satellites and exchange data received.
3. Coordinate launchings of satellites to learn more about the magnetic lines of force surrounding the Earth.

The details were worked out in talks at New York and Geneva by Dr. Hugh L. Dryden, deputy administrator of the National Aeronautics and Space Administration, and Soviet academician A. A. Blagonravov.

NASA Administrator James E. Webb called the cooperative program "an important step toward cooperation among nations of the world to increase man's knowledge and use of his spatial environment."

"The United States will make every effort to facilitate this undertaking," Webb added. And M. V. Keldysh, president of the Soviet Academy of Sciences, said "Soviet scientists are preparing to commence its implementation." (Source: The Atlanta Constitution, December 6, 1962)

SOVIET PARACHUTIST JUMPS 24.1 KM (15 MILES). The Soviet press reported, on November 14, that Major Yevgeny N. Andreyev had set what they thought to be a world record for a free fall without stabilizing devices.

It was reported that Colonel Pyotr I. Dolgov had died in the same test. Colonel Dolgov, whose death had been reported earlier this month with no reason given, opened his parachute upon stepping from the gondola of the balloon which carried them aloft and died during descent from unknown causes.

Krasnaya Zvezda, the Defense Ministry newspaper, said Major Andreyev's drop, lasting four minutes, disproved the theory that a stabilizing chute was essential in high altitude jumps. Without such a device, it had previously been believed, a man would be unable to keep from spinning and would soon black out.

Andreyev told Soviet newsmen that the temperature was -25.6°C (-78°F) when he jumped and that he reached a speed of 341 kilometers per hour (550 miles per hour) before hitting the denser air which slowed him down as he fell. At the 1525 meter (5000 ft) mark, an automatic signal told him to open his chute. This was accomplished at 793 meters (2600 ft.). (Source: New York Times, November 15, 1962)

WILL COSMONAUTS FLY AGAIN? The Soviet newspaper Izvestia quoted the "leader of the group of Soviet cosmonauts," Dr. Yevgeni Anatoliyevich, as saying, "It is quite likely that in the comparatively near future some of the present quartet of 'cosmic brothers'--Gagarin, Titov, Nikolayev, and Popovich--will once again join a sub-group of immediate flight readiness. A man traveling in outer space for the second time will be able to see and understand there much more than a newcomer."

The group of cosmonauts is still engaged in physical and mental training as Dr. Anatoliyevich said, "These flights are not very far off." (Source: Flight, October 25, 1962)

ROCKETS SAVE GRAPES. The grape crop of the mountain valleys of the Georgian SSR has for centuries been periodically destroyed by hail.

In a recent report, E. Pesova told of how now specialists of the Institute of Geophysics of the Academy of Sciences of the Georgian SSR have successfully developed a method for prevention of such catastrophes.

This method involves the use of an antihail rocket which injects a reagent into clouds which may produce hail. On passing through the cloud the rocket releases a mist whose particles cause the crystallization of supercooled cloud droplets. Hailstones are thereby prevented from becoming larger. Droplets are transformed into crystals and fall as harmless snow.

The area protected against hail is being extended. Tens of thousands of hectares (one hectare is 2.41 acres) were protected in the Alazanskaya Valley in 1961; in 1962 the protected area will be increased to 100,000 hectares. A special antihail service has been established at Telavi. (Source: Soviet-Bloc Research in Geophysics, Astronomy, and Space, No. 40, 1962)

FROM THE SEMITECHNICAL LITERATURE

SOVIET SPACE "EYE" IS LARGEST IN EXISTENCE. The following information, by Walter Sullivan, was taken from The New York Times, December 5, 1962, and is the most detailed report to appear in the news concerning the 7.9 hectare (20-acre) radiotelescope the Soviet Union is building.

The Soviet Union is building a 7.9 hectare (20-acre) radio "eye" to gaze into the farthest reaches of space.

The Soviet Union believes it to be the largest radiotelescope in existence. It is modeled after the cross designed by Dr. Bernard Y. Mills of Australia.

The antenna design has come to be known as "the Mills Cross." The out-sized version nearing completion here is popularly referred to by Western astronomers as "the Red Cross."

It is the prime feature of the radioastronomy station operated near Serpukhov, 88.5 km (55 miles) south of Moscow, by the Lebede Institute of Physics of the Soviet Academy of Sciences. The components of the telescope have been designed along gargantuan lines, presumably at heavy cost.

Another instrument, at the same site, is a parabolic antenna 21.9 meters (72 ft) in diameter. According to Western specialists it is built to greater precision than any "dish" in the West of comparable size.

It is of massive construction, far heavier than most Western antennas of this sort, and is mounted on what seems to have been a battleship gun turret.

Both antennas are designed to observe radio emissions from sources far out in space. The dish can record signals with wavelengths as short as 8 mm. This means that its shape must remain precise to within a small fraction of 8 mm despite sagging as it changes its aim, and despite temperature changes.

This ability to scan on short wavelengths makes it ideal for observing temperature-generated emissions from the planets. Such emissions are one of the strongest indications of the environments that we may expect on Mars, Venus, the Moon and other bodies.

The chief characteristic of the cross is its ability to collect a considerable amount of radio energy coming from an extremely small area of the heavens. Its two components are an east-west array and a north-south array, each km (0.621 mile) long.

The east-west array consists of a line of 37 parabolic trusses, each mounted on a tower more than 19.8 meters (65 ft) tall, supporting a succession of east-west wires. The trusses can be rocked, by synchronized motors on each tower, to aim the system.

The north-south array cannot be moved mechanically, but its aim can be controlled electronically. The system is so wired that it only "sees" emissions from that spot in the heavens visible to both arms of the cross.

The mesh of the north-south array is mounted on poles to form a long, parabolic segment of a cylinder. Its central axis, close to ground level, is said to be strong enough so that trucks servicing it can use it as a highway.

Because this array is some 19.8 meters (65 ft) lower than the east-west arm, radio waves striking one will differ slightly, in phase, from those hitting the other. In the sense of water waves, they might strike one array at their crest and the other array at their trough. This must be corrected electronically.

Beneath each of the 37 towers of the east-west arm is a concrete vault housing the electronics for that part of the system. All the vaults are linked to the master control center, from which the entire, kilometer-long array can be rocked in unison.

The observatory is under the direction of Dr. Viktor V. Vitkevich and is an important part of the growing science complex at Serpukhov. That city is also the site of the world's largest atom-smasher likewise under construction.

The radioastronomy center is said to have a staff of 450.

According to Dr. George W. Swenson Jr., Professor of Electrical Engineering at the University of Illinois, who has visited the site, construction of "the Red Cross" should be nearing completion. Another, of comparable size, is being built in Italy, near Bologna, he says, but is at an early stage.

The first such cross was built in Australia in 1954. Another, temporary one, erected in Maryland by the Carnegie Institution of Washington, made a historic discovery of radio emissions from Jupiter.

A modified Mills cross is reportedly being built on Clark Dry Lake, California, by Dr. William Erikson of the General Dynamics Corporation. Other crosses have been built, but not according to the same principle.

In spite of the antennas at Serpukhov and elsewhere in the Soviet Union, this country apparently still lacks equipment for tracking its vehicles on distant ventures into space. Thus, for example, it has depended to a considerable degree on the great 76.2 meter (50-foot) dish at Jodrell Bank in England to listen to transmissions from the Soviet vehicle now on its way to Mars.

Geography is also a problem in this respect. For a part of each day, such vehicles are not above the horizon of any Soviet station. The United States has three 25.9 meter (85-foot) dish antennas spaced around the world as its Deep Space Instrumentation Facility. They are in California, Australia, and South Africa. For comparable coverage the Russians must use ship-borne equipment. (Source: The New York Times, December 5, 1962)

"LIVING FOSSIL" ALGAE FOUND. Dr. N. Chudinov, a Soviet scientist, has reported a rather startling discovery. He claims to have brought to life fossil algae that previously lived about 200 to 350 million years ago.

Dr. Chudinov discovered the algae while searching for the cause of color staining of salt deposits in the foothills of the Urals.

The algae, red and yellow species, are believed to be purest in amounts of up to hundreds of tons in size. The deposits consist of alternating layers of sodium, potassium, and magnesium chlorides. The algae is claimed to have been found in the potassium and magnesium salts.

A report from the laboratories of the Berezniki Potassium Combine, assisted by the Paleontological and Botanical Institutes of the USSR Academy of Sciences, explained that they dissolved away the salt and found that the coloration was due to species of algae entombed in the salt and they could not classify as any known kind. It was then that the amazing discovery was made that the algae were showing signs of life. The algae were transferred to various culture media until they began to reproduce and form large colonies. Also, bacteria associated with the algae apparently came to life again.

The experiments were reported on a large number of samples taken from different salt deposits and, according to Dr. Chudinov, strict precautions were taken against contamination with contemporary species.

Another curious feature of this algae is that they appear to contain more silica and less carbon in their biochemistry than similar modern algae. (Source: New Scientist, October 25, 1962)

EAST GERMANY HAS WORLD'S BIGGEST UNIVERSAL TELESCOPE--200 CM (78.7 IN.) IN DIAMETER. According to Dr. Rudolf Jobst a giant universal telescope with a 200 cm (78.7 in.) spherical reflector provided with four different optical systems, for a wide variety of astronomical and astrophysical purposes, is now in operation in East Germany. Three more are planned, two for the Soviet Union and one for Czechoslovakia.

A universal reflecting telescope, the biggest of its type in the world, is now in operation at the rebuilt Karl Schwarzschild Observatory at Taubenburg, East Germany. The telescope is of 200 cm (78.7 in.) diameter and has four separate optical systems (Fig. 1) designed to cover the entire range of astronomical and astrophysical observation required now and in the foreseeable future. It can be changed over to the system appropriate to each piece of research, and each system has the same facilities as a single large specialized telescope of the same size and type.

When studying the Milky Way and extragalactic objects, and in fundamental astrophysical research, the Schmidt system (Fig. 1a) is used; this employs the main spherical mirror, which has a diameter of 200 cm, a correcting plate of 134 cm (52.7 in.), a focal length of 400 cm (13 ft), and an aperture ratio of 1:3. With the Schmidt system in operation the Taubenburg telescope is the largest effect star-mapping telescope in the world, permitting distortion-free photographs of extensive areas measuring about 11 square degrees to be taken on 24 cm x 24 cm plates (9.4 x 9.4 in.).

Observations of particular cosmic gas clouds and distant spiral nebulae are undertaken with the high-power Newtonian system (Fig. 1b) in operation, using the full aperture of the reflector. To compensate possible errors arising because the big reflector is spherical rather than parabolic in cross-section, a small lens correcting system is incorporated at a point near the image plane.

The Cassegrain system (Fig. 1c) serves for spectrographic investigation, mainly photoelectric photometry, of fixed stars down to the lowest order of brightness. Because of its effective focal length of 20 meters (65.6 ft) this system enables individual observations to be made successfully even in areas abounding with the stars. The Cassegrain system combines a super-hyperbolically deformed convex mirror of 40 cm (15.75 in.) with the 200 cm concave reflecting mirror.

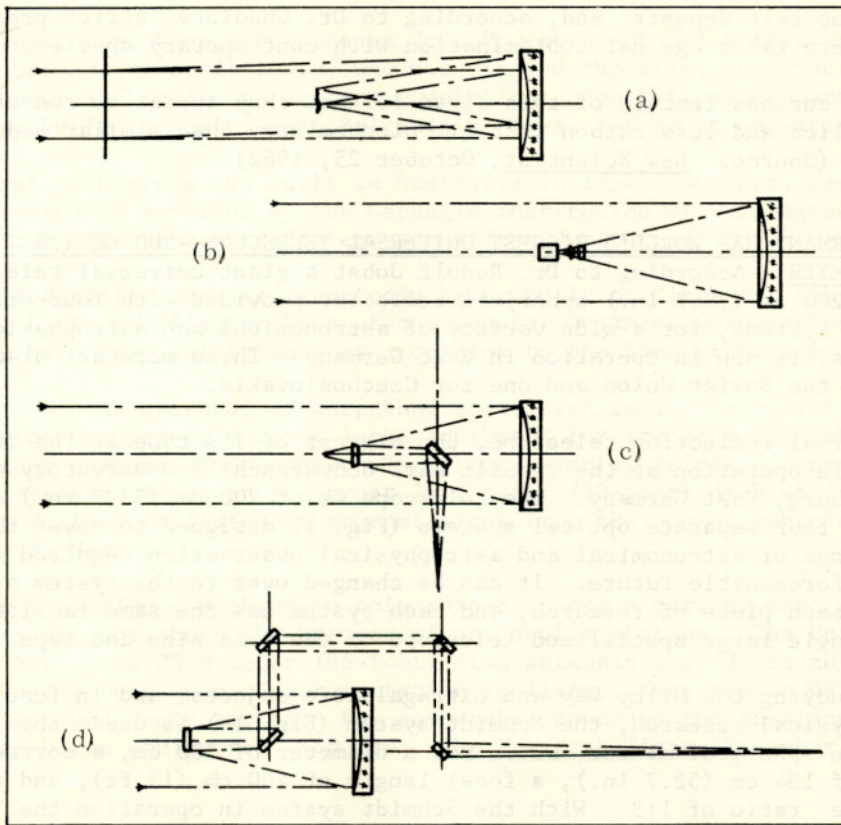


FIG. 1. (a) Schmidt system, (b) Newtonian system,
(c) Cassegrain system, (d) Coudé system

The Coudé system (Fig. 1d), using the same optical arrangement as the Cassegrain system but with another and even more powerful convex mirror, has effective focal length of 92 meters (300 ft). Combined with spectrographs giving very large separation of the spectral lines, the Coudé system permits the delicate line structure in the spectra of the stars to be examined. The ray path is diverted into the spectrographs installed in air-conditioned rooms kept at a constant temperature and humidity. The facilities afforded by the Coudé system are used for joint research by astrophysicists and nuclear physicists who find in the cosmos possibilities for fundamental study far beyond those available in the laboratory.

The telescope has been built by VEB Carl Zeiss Jena. It consists of a tube weighing 26 tons and about 10 meters (32 ft) long with a square cross-section. It is mounted on a moving cradle. Since the moving parts

weigh 65 tons, an oil-pressure suspension is provided to ensure that the telescope can be made to follow the course of the stars with the accuracy of a chronometer. Supported on a film of oil only 0.05 mm thick, the telescope is moved by means of a precision worm gear of 216 cm (85 in.) diameter, with helical teeth that deviate from the theoretical position by less than 0.5 sec of arc.

Each movement of the tube around the axis of declination and around the polar axis is transmitted by rotary indicators to one central and several subsidiary control desks, where the telescope is aligned by electrical power with the astronomical coordinates of the celestial bodies. Compensating devices ensure that the required adjustment and position of the optical elements of the telescope are maintained whatever the orientation of the telescope and regardless of temperature changes.

The 200 cm main reflecting mirror, which weighs 2,370 kg (2.29 tons), the 38 mm thick correcting plate, and the various subsidiary reflectors have been supplied by VEB Jenaer Glaswerk Schott und Gen, which also carried out part of the optical processing work. The manufacture and finishing of the correcting plate, of UV-permeable glass, and the two Cassegrain and Coudé mirrors, whose surfaces vary from the perfectly spherical by less than 0.05 mm, presented processing problems of exceptional difficulty.

The Zeiss spectrographs are fitted with diffraction gratings which permit the transmission of spectra of a maximum width of 150 cm. One diffraction grating was received as a gift from the Soviet Academy of Sciences; others were made by Zeiss.

A dome specially designed by Carl Zeiss Jena, measuring 20 meters (65.6 ft) across and weighing 175 tons, provides complete protection for the entire telescope and its equipment. Efficient insulation ensures that the night temperature is maintained within the dome in spite of general temperature rises in the daytime. Possible ill effects on the reliability of the mechanical and optical systems arising from temperature fluctuations are thus reduced to a minimum.

As astronomical observations with the Tautenburg telescope are getting under way, Carl Zeiss Jena has started work on three more 200 cm universal reflecting telescopes of the same type, two for the Soviet Union and one for Czechoslovakia. These three instruments will incorporate a number of improved features developed as a result of experience in making and testing the original telescope at Tautenburg. (Source: New Scientist, No. 299, August 9, 1962)

A ROYAL AIR FORCE SPACE PATROLLER. In an article by a British writer, E. Colston Shepherd, it is reported that the Minister of Aviation announced, during the month of September, that Dr. Barnes Wallis is designing a manned military space vehicle.

For at least the past seven years, the RAF has been thinking forward to the day when manned orbital patrols will become necessary for reconnaissance, for the identification of space vehicles and for the interception of such as are unwelcome.

What has been thought of is not the familiar capsule satellite capable of only limited navigational freedom but a winged vehicle which can toboggan in and out of the Earth's atmosphere and so can have at its disposal what has been called "an infinite choice of flight paths" as well as the irreplaceable "discretion of the human element." An announcement by the Minister of Aviation that the design of such a military vehicle has been undertaken by Dr. Barnes Wallis, shows that the aim persists and that Britain will pursue it in her own way.

How it will be done is not yet clear. Preliminary research and experiment by the Royal Aircraft Establishment at Farnborough and by Bristol Siddeley suggest that it will bear only a slight resemblance to the Dyna-Soar project which is due to reach the trial stage in the course of the next two years. The Dyna-Soar idea is intended to be a glider; the British orbit patroller will more probably be a powered airplane. The Dyna-Soar will be launched into orbit by a powerful two-stage rocket; the British vehicle will certainly make use of ramjet power for its climb through the thicker layers of the atmosphere and probably in the thinner layers too. When once the Dyna-Soar has sunk back into the atmosphere, it will not be able to accelerate itself back into orbit to resume and extend its patrol, whereas that is exactly what the British vehicle should be able to do.

Britain has her work on ramjets to thank for this possibility. It has been going on for 20 years and, in the last five years, has been at the heart of one of the most successful anti-aircraft guided missiles, the Bloodhound. The Thor ramjet in that missile is believed to operate at about Mach 4 but is capable of advancing to Mach 7. A similar unit, developed for supersonic burning, is thought to be suitable for speeds up to Mach 12. That, of course, is not enough to put a vehicle into orbit. Beyond that speed the specific fuel consumption of the ramjet is likely to exceed that of a rocket. Thus, the final stage of acceleration above a height of around 30,500 m (100,000 ft) will probably have to be done by rocket power--but the size and rating of the rocket will be modest in the extreme as compared with the booster of 1,000,000 lb of thrust which will be needed to start the Dyna-Soar on its way.

Thus, the likelihood seems to be that the idea of the pick-a-back airplane which Britain used as far back as 1938 will be applied. A load-carrying airplane powered with gas turbines for the take-off and with ramjets for the supersonic climb, will take the space vehicle up into the thin air and there launch it. In 1938, an ingenious combination of wing forms led to an automatic separation of the two aircraft at a predetermined

speed at which the difference in lift coefficients between the two wings generated enough pull to overcome the restraint of the attachment. With rocket power to launch the upper component, that will not be necessary nor, since Dr. Wallis is handling the design, are the wings of the spacecraft likely to be extended at that stage. As we are approaching the era of new, long-burning rockets of relatively small thrust, the provision of power for the maneuvering of the vehicle on the edge of space [possibly in a 483 km (300 mi) orbit] may not follow conventional lines.

Already some experiments have been done in wind tunnels at Farnborough on the subject of launching a rocket-driven load from the back of a mother airplane. Mr. M. J. Lighthill, the director of the Royal Aircraft Establishment, has said that they tried a model consisting of the carrier with both one and two stages above it, and came to the conclusion that the idea was feasible. The carrier airplane would have its gas turbines and its battery of ramjets underneath the delta wing. This is a verdict, naturally, on the aerodynamic and mechanical aspects of the proposal. It takes no account of processes by which the ramjets can be made fit for operation at high Mach numbers or of the material difficulties which will have to be overcome before a vehicle can be subjected to temperatures in the neighborhood of 2,000°C. Those difficulties are beginning to be understood as the result of reentry experience.

There is an inclination to assume that Russia and the United States alone have had the opportunity to acquire that experience, but in fact the British Black Knight rocket has been used in the past two years for reentry experiments. Its upper stage has been rocket-driven downwards from a height of about 112 km (70 miles) and so has been made to accelerate to a speed of 16,100 km. The nose cone, detached from the upper stage for the last part of the descent, was given an ablative and protective covering and thus made to yield first-hand information on the subject. Applying the knowledge to an airframe which must endure a similar degree of heating for a few minutes will involve a good deal of development work. Here again, Britain is acquiring her own fund of experience with the 188 stainless-steel airplane just as in the United States the X-15 rocket airplane, making plentiful use of a special nickel steel, has taught designers much that is valuable about primary structures.

Conclusions to be derived from these airplanes are limited. The 188 is capable of Mach 3 and the X-15 of Mach 7, whereas the orbit patroller will encounter its worst heating trial at Mach 18 or Mach 19. The Dyna-Soar is being built on that assumption. Taking account of this condition means more than coating the leading edges and the underpart of the glider with ceramics and graphite materials. It means allowing for a wide margin of difference in expansion and contraction as between various parts of the structure. In this respect, some guidance has also been obtained from the X-15, in which the range of material temperatures during flight in different parts of the structure at the same time has been reported to be 649°C to -184°C. To meet this awkward structural perturbation, the X-15 is being built of deeply corrugated panels linked with special expansion joints.

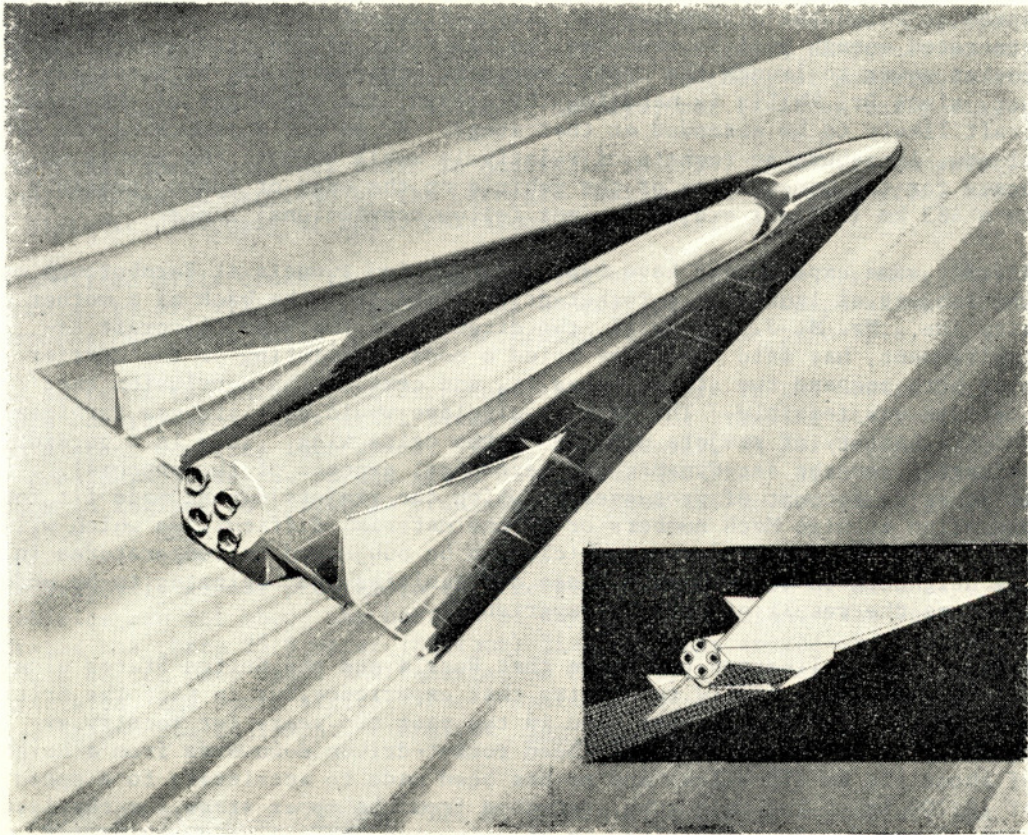


FIG. 2

An artist's impression of a recoverable vehicle propelled by air-breathing engines used as the first stage of a satellite launching system. At a speed between Mach 10 and Mach 14 the upper stages separate and continue under rocket power, while the first stage vehicle returns to base.
(Bristol Siddeley Engines Ltd.)

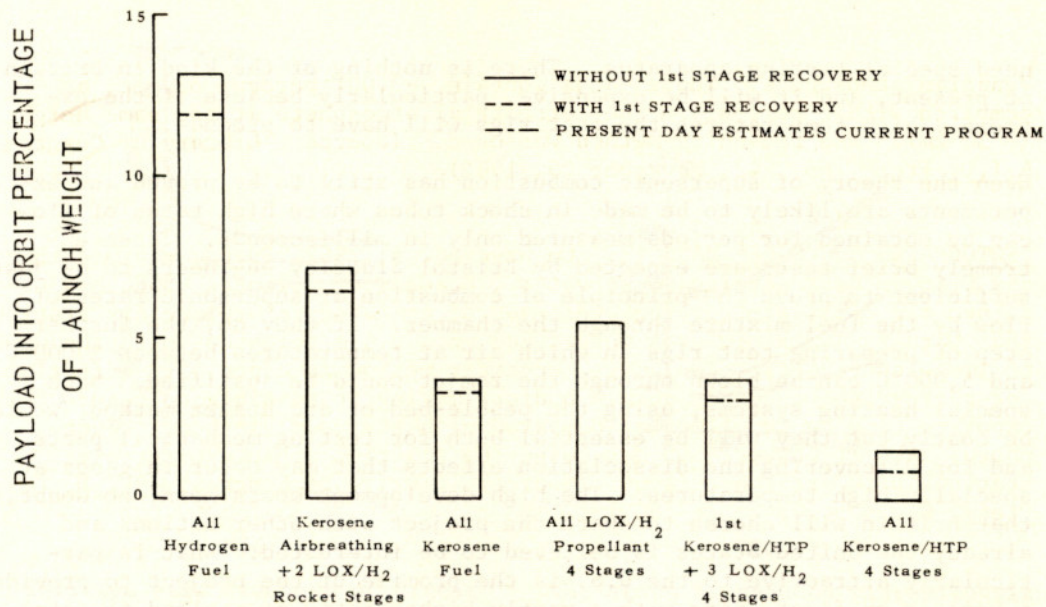
For the British project similar or corresponding devices will have to be applied. The development work will certainly take a long time. That is equally true of the ramjets which will carry the space vehicle up into the thinner layers of the atmosphere. Those presently available employ subsonic burning, and this affords efficient and economical thrust up to a forward speed of Mach 8. Beyond that, supersonic burning should yield efficient thrust up to Mach 14, although fuel economy in comparison with rocket thrust at high speed in thin air may well set the limit for this application at Mach 12. Anything suitable for speeds above Mach 7 will

need special testing apparatus. There is nothing of the kind in Britain at present, and it will be expensive, particularly because of the extremely high temperatures the test rigs will have to produce.

Even the theory of supersonic combustion has still to be proved and experiments are likely to be made in shock tubes where high rates of flow can be obtained for periods measured only in milliseconds. These extremely brief tests are expected by Bristol Siddeley engineers to be just sufficient to prove the principle of combustion at supersonic rates of flow by the fuel mixture through the chamber. If they do, the further step of preparing test rigs in which air at temperatures between 2,000°C and 5,000°C can be blown through the ramjet would be justified. Such special heating systems, using the pebble-bed or arc heater method, would be costly, but they will be essential both for testing mechanical parts and for discovering the dissociation effects that may occur in gases at specially high temperatures. The high development costs mean, no doubt, that Britain will choose to share the project with other nations and already the United States is believed to be interested. What is particularly attractive to the U.S. is the promise of the project to provide a booster or first stage with a vastly higher ratio of payload to total weight than can be achieved by any type of existing rocket.

This can be viewed either as a boon in putting unusually big satellites into orbit or as a cheap way of getting things into space. The former advantage may appeal more the United States and the latter to Britain. In some calculations, the prospect of putting about 45,000 kb (50 tons) into an approximately 483 km (300-mile) orbit for a total take-off weight of about 204,000 kg (225 tons) has been advanced. At the other end of the scale, a 4,500 kg (10,000-lb) combination could be expected to launch 810 kg (1,800 lb) into orbit. Expressed in terms of money, this might mean a cost of \$140 per lb of satellite as against \$560 per lb using the great Saturn rocket as booster, for the 483 km orbit. Figure 3 shows comparative payloads, in relation to launch weight, for multi-stage rockets and the proposed combination, using various fuels.

Britain's primary interest concerns the putting into orbit of a manned airplane which can ultimately return to Earth. Aerodynamically, the design of this vehicle and of its mother airplane naturally points to Dr. Wallis and some development of his folding wing system. Part of the task will be that of cooling the cabin and the supply of cooling air for it. Dr. Wallis long ago worked out an ingenious double-skin idea for the exposed parts of his proposed supersonic air liner. His scheme, roughly, was to support the outer skin on widely-spaced studs. With the excessive heating on the climb and at reentry something more will doubtless be needed for the cabin. As the Bristol Siddeley engineers expect to use liquid hydrogen as the fuel, this suggests that the example of the U.S. in the Dyna-Soar might be followed. They intend to circulate liquid hydrogen as a cabin cooler, passing it through a heat exchanger as a way of cooling the cabin air.



AIR BREATHING + 2 ROCKET STAGES. MULTI-STAGE ROCKETS

Comparison of ground-launched satellite boosters. (Bristol Siddeley Engines Ltd.)

(Source: New Scientist, Sept. 13, 1962)

FIG. 3

The whole project will be costly in development. A rough figure of \$280,000,000 has been given. It will clearly take time. The Minister of Aviation in Britain, recently moved from the Air Ministry, says he is sure the RAF will have an "operational requirement" for this space patroller by 1970. (Source: New Scientist, September 13, 1962)

FROM THE TECHNICAL LITERATURE

ASTRONOMY

OXYGEN REPORTED ON VENUS. Komsomol'skaya pravda announced on November 17 that Professor V. K. Prokof'yev of the Crimean Astrophysical Observatory has discovered faint bands of oxygen in the outer layer of the

Venusian atmosphere. These bands contain ~ 0.001 percent oxygen, as compared with 1 percent in the terrestrial atmosphere at the same height (~ 30 km). The red-shift method was used. (Source: Library of Congress, A.I.D. Press, No. 847, November 29, 1962)

PHOTOGRAPHS TAKEN OF MARS 1. On November 6, 1962, Pravda claimed that the Crimean Astrophysical Observatory, Academy of Sciences USSR, had obtained the first photographs ever made of a moving interplanetary station, the Mars 1. Six pictures were taken on a 2.6-m telescope with the use of image converters. The image converter method is especially effective for photographing moving cosmic bodies, making it possible to reduce the exposure time by 100 times as compared with the usual methods. Such photos make it possible to determine the position of interplanetary stations with great accuracy. (Source: Library of Congress, A.I.D. Press, No. 836, November 13, 1962)

ASTROPHYSICS

SPATIAL PERCEPTION AND ORIENTATION STUDIED BY RUSSIANS. M. D. Yemel'yanov and Ye. M. Yuganov report that Soviet scientists have been conducting studies in spatial perception as part of their program for the conquest of space. Since spatial perception and orientation depend on the interaction of a number of senses (visual, vestibular, proprioceptive, etc.), studies were conducted to establish the relationship between these senses by means of rocking and rotating chairs on steady and unsteady supports and a cylinder with alternate white and black bands on the inside.

Lateral movements of the body, biopotentials of skeletal muscles, pulse, respiration, blood pressure, and biopotentials of the brain were recorded. Results of blindfold tests showed that static muscular efforts by persons on fixed (i.e., steady) supports resulted in a marked inhibition of vestibular and spinal reflexes. However, when a person was balancing on an unsteady support an increase of vestibular reactions was recorded. The vestibular reactions grew more pronounced as the stability of the area of the supporting surface decreased.

Rotation on a supporting surface of 625 cm^2 did not cause any marked motor reactions or sensations of antirotation. However, when the supporting surface was decreased to 289 cm^2 , deflections from the vertical position increased sharply, and continued action of the same stimulus led to complete disorientation in space, followed by symptoms of motion sickness (paleness, nausea, perspiration, and rapid pulse).

As the degree of support instability increased, biopotentials from the brain increased; this effect was accompanied by suppression of the α -rhythm and the appearance of the β -rhythm and lance-shaped oscillations, indicating a decrease of inhibitory processes in the cortex.

All of the above phenomena are related to the interaction of vestibular and proprioceptive senses in the absence of visual orientation. Vestibular responses are less pronounced when the eyes are open. Light, when entering the eye from a space devoid of reference points, however, has no effect on the inhibition of vestibular reactions. But fixation on motionless objects introduced into the field of vision caused such inhibition. On the other hand, observation of moving objects increased vestibular sensitivity.

Further tests indicated that maximum vestibular inhibition takes place when the object viewed is situated 40 to 100 cm from the subject along the central line at eye level. Objects situated closer or at an angle of vision of over 30° do not produce any inhibitory effect on vestibular reactions.

The discoveries provided the basis for the experimental reproduction of space illusions, which arise as a result of disturbance in the coordination of those senses which participate in spatial perception. (Source: Library of Congress, A.I.D. Press, No. 846, November 28, 1962)

HUNGARIAN COSMIC RADIATION STUDY. The cosmic radiation study group of Central Research Institute for Physics stated in Fizikai szemle, no. 5, 1962, that after the return of Professor Jánossy to Hungary, the Cosmic Ray Laboratory of the Central Research Institute for Physics was formed in 1950. Between 1950 and 1955, application of the following techniques was introduced: GM tube coincidence technique, Wilson chambers, and photoemulsion techniques. During the initial period of development, measurements published previously were repeated with greater accuracy.

In 1955-57 Jánossy and Kiss determined the average life time of μ -mesons with a delayed coincidence GM counter. GM counter measurements were applied by study the Rossi-diagram (transition characteristics of electron-photon showers on various absorbents). It was shown that the second maximum of the Rossi-diagram could not be detected.

Further the study is reviewed of (1) nuclear interactions of high-energy particles, and (2) intensity fluctuations of cosmic radiation. High-energy nuclear interactions were studied by GM coincidence techniques, by Wilson chambers, and by the investigation of streaks caused by the high-energy nuclear interactions of cosmic radiation particles in the photoemulsion.

Several papers were published by Janossy, Sandor, Somogyi and Gemessy on the study of extensive air showers. Their main results are summarized as follows: (1) The ratio of photo-electron component f/e was found to be 1.13 ± 0.03 ; (2) the transition curve of the extensive air showers was

studied; and (3) the temperature effect was studied and interpreted. The nuclear interactions of lower energy (10^{10} - 10^{13} eV) particles were investigated by the study of the penetrating showers (locally generated meson showers).

Bozóki, Fenyves and Jánosy determined the length of path of the active particles generating the showers, in lead and in carbon, and the mean free collision path of 30 GeV neutrons in lead, carbon and paraffin. The streaks formed in photoemulsions were studied by Bozóki, Domokos, Fenyves, Gombosi and Surányi. The angle and energy distribution of the secondary particles was investigated. The mechanism of formation of mesons was studied with beams of accelerated particles on the 10 GeV proton synchrotron of the United Atomic Research Institute of Dubna.

On the application of photoemulsion studies the following conclusions were reached:

1. In the case of interactions between nucleon and nucleus on the energy of 9 GeV, the results can be more accurately interpreted by the cascade model than by the tunnel model.
2. In case of interactions between π mesons and nucleons, two types of collisions can be distinguished: peripheral and central collisions, in which many π mesons are generated.

Brief details are given of the cooperation with the Cosmic Ray Laboratory of the Bulgarian Academy of Sciences on the Rila Mountain and the United Atomic Research Institute (USSR). (Source: English Abstract of Selected Articles from Soviet Bloc and Mainland China Technical Journal, October, 1962)

BIOPHYSICS

COMPARING DIRECT AND INDIRECT ACTION OF IONIZING RADIATION ON DNA. M. I. Mekshenkov prepared a paper which was presented to the Institute of Biological Sciences, Academy of Sciences, USSR on the dangers of radiation. In the paper he said the effects of ionizing radiations' primary actions (oxygen, protective, temperature effects, and pH dependence) involve quite different mechanisms, depending whether the actions are direct or indirect. Experimental results, to be reported, were obtained through data on x-ray exposures of DNA in concentrations of 0.007 to 100 percent.

D. E. Lea, in the British Journal of Radiology, summarized data on direct and indirect action on various classes of compounds, including substances such as proteins, enzymes, and virus particles. A result comparison yields the general conclusions: (1) The ionic yield for direct action on various compounds, including those in different aggregate states, with molecular weights from 20 to 10^7 units, varies between 0.4 and 4 molecules per ion-pair, and reveals no molecular weight dependence.

(2) Ionic yield for indirect action rapidly diminishes from a few units for simple molecules to 10^{-4} for those like nucleoproteins. Lea's virus data show direct action effectiveness 10^4 times greater than indirect action.

Later works report that the ionic yield of direct action was 5 to 10 times higher than indirect action for various kinds of proteins and enzymes. G. C. Butler, reporting in the Canadian Journal of Research, obtained an ionic yield of 0.02 for indirect action on DNA, two orders less on the average than the values for direct action. W. M. Dale, in the Biochemical Journal, showed that the ionic yield of breaks of the main chains by radicals was much less than unity. Recently, Butler et al. obtained data relating the 50 percent dose ($D_{50\%}$) with the concentration of DNA solutions over the range of concentrations from 0.01 to 100 percent; from these data they concluded the relative effectiveness of direct to indirect action, β/α , was equal to unity. A more thorough examination of their data for the different DNA samples shows such a conclusion is obtained only by a very rough averaging, allowing an error of over 200 percent. In 1959 W. R. Guild and F. M. Defilippes determined the ionic yield of direct and indirect action on the transforming activity of DNA. Mekshenkov's calculation from their data yields a β/α of 4 - 5, whereas these authors thought their results agreed with Butler's conclusions. These conclusions agree with neither Butler's and Dale's early work, nor Mekshenkov's.

To obtain additional information, Mekshenkov measured relative effectiveness of direct and indirect action on DNA in concentrations from 0.007 to 100 percent, using the direct method of separating direct and indirect effects. As a protective substance Mekshenkov used the iodine ion (KI) which interacts very effectively with free radicals. Irradiation was carried out on the BF apparatus. The DNA preparation was isolated by Kirby's phenol method as modified by Georgiev. Solutions of high concentration were prepared for comparison by the method used by Butler and by "evaporation" in vacuum at 0° . In addition to the protection experiments, Mekshenkov repeated Butler's experiments. The results are given in Figure 4. For the two different samples at high concentrations, the calculations for β/α yields 8 (from curve 1) and 3 (from curve 2). The formula used to plot these curves was:

$$D_{50c} = \frac{D_{50d}}{1 + \alpha/\beta \cdot 1 - c/c} \quad (1)$$

It was found subsequently that formula (1) is generally inapplicable for the calculation of β/α at any concentration; Mekshenkov found that β/α varied distinctly with the concentration in experiments with protective substances. Under these conditions, formula (1) should be replaced with:

$$D_{50c} = \frac{D_{50d} \cdot \beta_0 / \beta}{1 + 1 - c / c \cdot \alpha / \beta} \quad (2)$$

Equation (2) cannot be used to calculate β/α from the data for D_{50c} and D_{50d} . Experiments in which protection against free radicals was provided allow a calculation of β/α with accuracy to small terms of the second order from:

$$\beta/\alpha = 1 - c/c \cdot \frac{\Delta \eta_d}{\Delta \eta_i} \quad (3)$$

The obtained relationship between the percentage and c is shown in Figure 5, the line $\beta/\alpha = 1$ shown for comparison. Results of β/α for various concentrations are given in Figure 6(a), showing a rapid β/α increase with concentration reduction. Figure 6(b) demonstrates, for q , a constant, direct action in a DNA solution, the observed increase of β/α is largely due to the increase in effectiveness of direct action β/α_0 . Mekshenkov obtained the following fact incidentally: The curves (Fig. 7) relating to the reduced viscosity for control and irradiated samoles at $\underline{c} = 20$ percent with KI and without KI indicate the percentage protection evaluated from viscosity measurement $c = 0.005$ percent is equal to 25 percent, and at $c = 0.034$ percent is equal to 40 percent, i.e., the relative role of indirect action increases with the reduction in the concentrations at which the viscosity is measured.

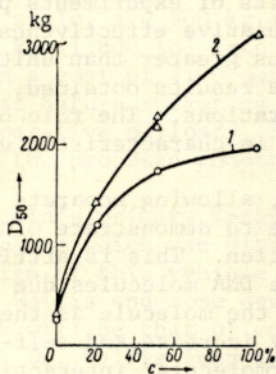


FIG. 4

D_{50c} as function of concentration of DNA solution. (1) DNA preparation with reduced viscosity in control 90 dl/g; (2) DNA preparation with reduced viscosity in control 35 dl/g.

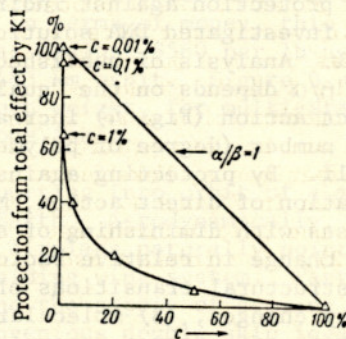


FIG. 5

Protection (as percentage of total change of reduced viscosity) as function of concentration of DNA solution.

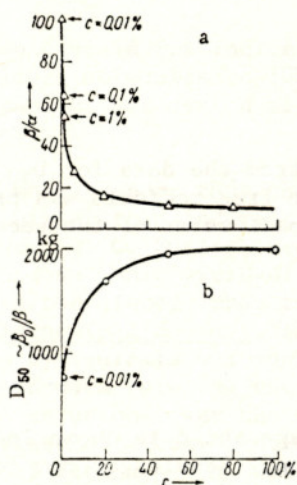


FIG. 6

Relative effectiveness of direct and indirect action β/α (a) and $D_{50d} = q \beta_0/\beta$ (b) as functions of concentration.

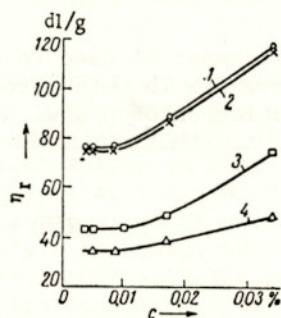


FIG. 7

Variation of reduced viscosity with concentration at which viscosity is measured for samples irradiated at 20% concentration. 1,2) Control samples; 3,4) irradiated samples 1,3) without KI; 2,4) with KI

Conclusions:

I. Curves for 50 percent dose and the results of experiments providing protection against indirect action show relative effectiveness of β/α on investigated DNA solutions is several times greater than unity.

II. Analysis of published data confirms the results obtained, indicating β/α depends on the "quality" of the preparations. The role of indirect action (Fig. 4) increases with increase in characteristic viscosity number (degree of polymerization).

III. By protecting against indirect action, allowing separate investigation of direct action, Mekshenkov was able to demonstrate β/α increases with diminishing of solution concentration. This is attributable to (1) change in relative radiosensitivity of the DNA molecules due to known structural transitions of forms A and B of the molecule as the humidity changes, (2) molecular skeleton rigidity increase, and self-protection effects increase with increasing intermolecular interaction with solution concentration increase, and (3) recombination increase, promoting reunion of chains temporarily separated by hydrogen bond weakening.

IV. The formula used for calculation of β/α should be replaced by the relationship presented herein. This relationship takes into account changes in effectiveness with solution concentration.

V. The protection experiments gave preliminary results indicating the role of indirect action is greater in effects responsible for DNA solution structural viscosity.

Nomenclature:

- D_{50c} = 50% dose for combined action
 D_{50d} = 50% dose for direct action
 c = DNA concentration
 β/α = relative effectiveness, direct to indirect action
 β_0 = effectiveness of direct action at 100% concentration (for dry DNA)
 $\Delta \eta_d$ = change in viscosity due to direct action
 $\Delta \eta_i$ = part of the effect removed by iodine ion

(Source: Soviet Physics Doklady, August, 1962)

LIFE SUPPORT

SPACECRAFT METEORITE PROTECTION. Work done on spacecraft protection from meteorites was recently reported on by Yu. M. Volynkin and P. P. Saksonov.

They say that protection of pressurized cabins against penetration by meteorites can be achieved by means of strong foliated (i.e., multilayer) envelopes. After breaking through one layer, it is hoped the meteorite will not be able to penetrate the lower layers. They also make a proposal to install on board spaceships special radar-directed guns which would automatically detect and destroy approaching meteorites. (Source: Library of Congress, A.I.D. Press, No. 846, November 28, 1962)

SOVIET ARTIFICIAL ENVIRONMENT IDEAS DESCRIBED. The most recent description of the Soviet ideas on spacesuits was given by A. M. Genin, O. G. Gazenko, and N. P. Sergeev at the International Symposium on Basic Environmental Problems of Man in Space in late October.

The space suit used on the Vostok flights consists of three coverall-like layers. The function of the outer layer is to contain excessive pressures from within. The second layer is a hermetically sealed envelope, and the third is a thermoinsulation suit with a ventilating system. The helmet is provided with a visor which can be operated both manually and automatically.

In case of pressure failure in the cabin, the visor closes automatically and an emergency suit-ventilation system switches on. Air supplied from storage containers is either an air-oxygen mixture or pure oxygen, depending on the barometric pressure within the cabin. Special regulators maintain the necessary pressure within the suit.

In case of an emergency water landing the space suit will keep the cosmonaut afloat on his back. The thermal insulation and sealing make it possible for the cosmonaut to remain afloat in water of 0°C temperature for 12 hours without discomfort.

The spacecraft itself was designed for 12-day operation and provided for storage of oxygen, carbon dioxide, water, and foodstuffs without use of recovery cycles. Oxygen was stored in the form of highly active chemical compounds from which it was easily extracted without additional consumption. These same compounds were then used for the absorption of CO₂ and the partial absorption of moisture and certain harmful admixtures. This system had a high reliability and a weight advantage over other systems. Regeneration of air and absorption of carbon dioxide and water vapor was initiated automatically by special sensors which activate oxygen production when the O₂ content in the cabin atmosphere fell below a certain level. Similarly, an excess of oxygen in the cabin caused the sensors to reduce oxygen production. It was possible to install the oxygen control mechanism without any appreciable increase in weight or decrease in reliability of the life support system.

For flight of more than 15 days' duration the use of stored oxygen, water, and food is not considered practical. The use of a water-regeneration cycle is feasible from the engineering point of view, but recovery of oxygen from carbon dioxide and metabolic water presents considerable technical difficulty. Flights of long duration can be carried out only with the regeneration of all components of the artificial environment, including the recovery of foodstuffs. This type of closed ecological system can be achieved only through the use of natural photosynthesis of green plants. Intensive investigations in this direction are being conducted, and experimental data already obtained provide grounds for believing that the problem will be solved in the near future. (Source: Library of Congress, A.I.D. Press, No. 846, November 28, 1962)

PHYSICS

RUSSIANS SOLVE PROBLEM OF THE MOTION OF A STABILIZED GYROSCOPE IN A CARDAN SUSPENSION. According to D. M. Klimov in an article appearing in Digest of Translated Russian Literature, Mr. Nikolai formulated and solved the problem of the motion of a stabilized gyroscope in a Cardan suspension, taking into account the effect of constant frictional moments at the suspension axes. The motion of an astatic gyroscope in a Cardan suspension on a fixed base is studied in this paper. It was assumed that there are frictional forces at the axes of the suspension, the magnitudes of which are proportional to the normals forming the dynamic reactions. (Source: ARS Journal Supplement, November, 1962)

RADIO COMMUNICATIONS

RADIO WAVELENGTH FORECASTING. On September 9, Znaniye-sila contained information about work being done in Poland on radio communications.

Engineers at the Polish Institute of Communications have recently suggested an approach to the problem of forecasting the best time and most appropriate wavelength for clear radio communications. As a result of a study of radio weather during the partial solar eclipse in February, 1962, it was found that a relationship exists between the phase of the eclipse (and hence the number of sunspots occluded) and the condition of the ionosphere. It was determined that, as a rule, the intensity of ionizing radiation of ultraviolet and x-rays has no bearing on the size of the spots. The Polish scientists have detected two groups of sunspots (occupying a negligible portion on the surface of the solar disk) which accounted for almost 25 percent of the ionizing solar radiation. (Source: Library of Congress, A.I.D. Press, No. 844, November 26, 1962)

SPACE FLIGHT

MARS 1 DESCRIBED. On November 6, 1962, Pravda contained an article vaguely describing Mars 1.

In reviewing Soviet space performance over the past five years, Academician L. Sedov writes that the successful launching of Mars 1, which weighs almost 1 ton, was a remarkable new scientific and technical achievement, greatly exceeding anything done previously. The launch required the use of new launching systems and was accomplished from a heavy artificial Earth satellite. Precise timing was required in switching on the power plant units and assuring the operation of all systems during the launch in airless, weightless space.

Since these conditions could not satisfactorily be simulated for preliminary research, success was assured by theoretical analysis. It was also necessary to develop essentially new systems which would function throughout the seven-month flight and could be controlled from a distance of hundreds of millions of kilometers. (Source: Library of Congress, A.I.D. Press, No. 839, November 16, 1962)

SPACE MEDICINE

SOVIET BIOMEDICAL RESEARCH ON SPACECRAFT. In a paper given at the International Symposium on Basic Environmental Problems of Man in Space, I. I. Akulinichev, R. M. Bayevskiy, and O. G. Gazenko reported that Soviet scientists used 13 different on-board methods of recording physiological parameters for transmission to ground stations during space flight.

Cardiac biocurrents were recorded by electrocardiography to measure myocardial automation, excitability, and conductivity on Sputnik 2, orbital spaceships 2, 3, 4, and 5, and Vostoks 1, 2, 3, and 4. Movements of the thoracic perimeter were recorded by pneumography on board the same space vehicles. Heart sounds were recorded by phonocardiographs to measure the operation of heart valves on orbital spaceships 2 and 3. Body vibrations caused by cardiac activity were recorded by seismocardiographs on orbital spaceship 3. Sphygmographs were used on orbital spaceships 4 and 5 to record vibrations of blood-vessel walls as an indication of vessel tonus.

Arterial pressure was measured on Sputnik 2 and orbital spaceship 2 by arterial oscillography. Kinetocardiography was used on Vostok 2 to measure local vibrations of the thoracic wall as an indication of the mechanical effect of cardiac contraction. The motor activity of body movements was recorded by actography on Sputnik 2 and orbital spaceships 2 and 3. Electromyography was used on orbital spaceship 3 to record muscle biocurrents as an index of motor activity. Skin thermometry was used to measure thermoregulation on orbital spaceships 2 and 3. The functional state of the brain was measured by using electroencephalographs to record brain biocurrents on Vostoks 3 and 4.

On the same spaceships eyeball movements were recorded by electrooculographs, which measured biopotentials of the eyeball, and the tonus of the sympathetic nervous system was recorded by movement of galvanic reactions of the skin to direct currents. Activity of bacterial cultures during space flight was measured by registration of gas production resulting from bacterial development. The operation of the environmental system was monitored by special sensors which recorded air pressure, temperature, humidity, and oxygen and carbon dioxide content.

In addition to in-flight monitoring, post-flight investigations of animals and other bioorganisms were performed. Muscle tone and nervous system activity were tested by electromyography and motor and food reflexes in rats and guinea pigs. Effects of space radiation and in-flight stresses were investigated by checking the albumin content of the blood, non-specific cholinesterase activity, and urine composition in dogs, rats, and mice. Immunological and biological reactions of dogs were tested by the study of the number of microorganisms on the skin and the phagocytic activity of neutrophiles.

The effect of space flight on the morphology of marrow cells and the organs of blood formation was determined by examination of the chromosome structure of marrow cells and the histological structure of the spleen. Cutaneous samples which had been exposed to space flight were reimplanted on their rabbit and human donors. Plant seeds and fruit flies were studied for the frequency of recessive lethal and dominant mutations. (Source: Library of Congress, A.I.D. Press, No. 846, November 28, 1962)

ANTIRADIATION DRUGS. Soviet space biologists, report P. P. Saksonov, V. V. Antipov, and N. N. Dobrov, are very much interested in the chemical and pharmacological protection against radiation afforded by the following drugs: cysteamine (β -mercaptoethylamine), AET-S (β -aminoethylisothiuronium bromide), serotonin, 5-oxytryptamine, and others.

They have found that cysteamine, cystamine, serotonin, and AET exert a protective influence during the irradiation of animals by high energy protons. They feel that the most effective means of chemical protection will consist not of one substance but of several, with different pharmacological properties. S. P. Yarmonenko, V. S. Shashkov, and other investigators feel that the use of antiradiation drugs will make it possible to reduce the weight of physical protection and thus increase duration of flights. (Source: Library of Congress, A.I.D. Press, No. 846, November 28, 1962)

SUPPORT SYSTEMS

RUSSIAN LUNAR LANDING PLANS. Nikolay Varvarov wrote an article in a Baku newspaper some time ago that stated that at the present time it is entirely possible for automatic stations to make a soft landing on the Moon. However, it is essential to know the composition and mechanical properties of the lunar surface material in order to properly design the space vehicle. It must be remembered that when the vehicle lands a great amount of red-hot gases released from the braking rockets will melt or otherwise change the surface at the point of landing. This will make it useless to study the surface conditions in the immediate vicinity of the landing. Means must therefore be found to automatically remove the scientific instruments several kilometers away, if the surface is solid, or several tens of kilometers if the surface is dust. This is essential in order to determine the true properties of the undisturbed surface, including its depth, heat regime, level of radiation, etc.

Manned landing will be preceded by repeated manned flights around the Moon, and only after the landing of spacecraft carrying plants and animals. Scientists are planning Earth satellite fueling stations to facilitate manned flights to the Moon. (Source: Soviet-Bloc Research in Geophysics, Astronomy, and Space, No. 40, 1962)

BOOKS. The following book reviews have been selected from publications as noted.

Shal'nov, M. I., Neutron Tissue Dose.

This book represents an attempt to generalize the data culled from the literature, as well as the materials obtained by the book's author in his own experimental work with neutrons, on all of the principal questions

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The appendix informs on methods for the practical utilization of the material included in the handbook.

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