Space INTELLIGENCE NOTES

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FROM THE WORLD PRESS

SOVIETS SEEK INTERNATIONAL COOPERATION FOR MOON TRIP. Following a 3-wk, 19,000-km (12,000-mi) tour of USSR space tracking observatories, Sir Bernard Lovell, head of the British Jodrell Bank Observatory, stated that the Russians apparently were not convinced of the desirability, scientifically or otherwise, of placing a man on the Moon. This conclusion was based upon a study of Soviet lunar intentions, which included the present Russian opinion that instruments can acquire as much information as humans.

M. V. Keldysh, president of the Soviet Academy of Sciences, was likewise credited with the belief that the only way to proceed with a man-on-the-Moon program is to obtain international agreement of its desirability. Sir Bernard mentioned that the Russians are planning to launch an orbital platform containing a 914-mm (36-in.) -dia telescope, weighing an aggregate of several tons, within the next 5 yr. The platform, which would be orbited at a similar height to the present Soviet space vehicles, would remain in space for 5 or 6 days at a time; two persons would operate the telescope.

Soviet Academy of Sciences personnel are greatly concerned with radiation damage and the lack of a solution to return man safely to Earth because of the inadequate level of radiation protection. Although present forecasting devices can provide 24-hr warning of a solar radiation attack, this would be insufficient time to allow people to get off the Moon. It would, however, be adequate to permit personnel on a space platform to return to Earth.

The tour of nine major Soviet observatories was climaxed by an Anglo-Soviet agreement for cooperation in deep space probes by a Soviet tracking station in the Crimea and Jodrell Bank. The agreement included joint cooperation on three astronomical problems for which the Soviet and Jodrell Bank telescopes would be synchronized. These would include radar study of Venus, Mars, and Mercury, as well as investigations of certain stars.

Jodrell Bank, a part of the Department of Radio Astronomy at Manchester University, expends 95 per cent of its effort on radio astronomical research, with the remainder devoted to deep space tracking. (Source: The New York Times, July 17, 1963)

VIKTOR AMAZASPOVICH AMBARTSUMIAN: A PORTRAIT. Viktor Amazaspovich Ambartsumian, president of the International Astronomical Union, has greatly shaped and influenced the development of astrophysics and stellar astronomy in the USSR. He is also well known in foreign scientific circles and holds membership in the Academies of Science of Paris, Washington, Berlin, Vienna, Liège, and Boston.

Ambartsumian entered the Physical Mathematical Faculty of the University of Leningrad with the intention of devoting his life to a study of astrophysics. His first paper, on solar faculae, was published in 1926 after he was graduated. In 1928, he became a postgraduate student at the Pulkovo Observatory in Leningrad, having already published ten scientific papers.

At the Pulkovo Observatory, where he studied from 1928 to 1931, Ambartsumian did research in the areas of physics, stellar atmospheres, and gas nebulae. He worked at the Leningrad University as head of the Astrophysical Department and director of the Astronomical Observatory from 1931 to 1943. From 1941 to 1943, he was Pro-Rector of the University.

In 1932, Ambartsumian presented his paper "Radiative Equilibrium in Planetary Nebulae," the first of a series of papers on the physics of gaseous nebulae, devoted to such problems as the transfer of energy, excitation and ionization of atoms, and emission of "forbidden" lines.

He collaborated with N. A. Kozyrev in 1936 and succeeded in evaluating the masses of the envelopes ejected by novae. Viktor Ambartsumian is accredited with the formulation of a special system of physical statistics for stellar systems, using their real properties.

Between 1937 and 1943, Ambartsumian proposed two new theories, the fluctuation theory and the principal of invariance, which have played a great role in the investigation of the properties of dust nebulae and in the study of atmospheres of the planets, stars, and Sun, respectively.

In 1947, Ambartsumian moved to Erevan, the capital of Armenia, and began work at the Academy of Sciences of the Armenian Soviet Socialist Republic. He also lectured at the University of Erevan and initiated the construction of the Burakan Astrophysical Observatory.

That same year Ambartsumian discovered a new, very young stellar system, which he named Stellar Associations. This discovery confirmed the belief that star formation in our galaxy is still continuing and that stars may be formed in associations as groups of multiple stars.

Ambartsumian's latest efforts have been concentrated on extragalactic nebulae. He has observed a vast number of dynamically unstable systems among multiple galaxies. This suggests that these systems are very young. He has also concluded that multiple galaxies were formed by the disintegration of very dense formations, which are still of unknown nature. These observations are of importance, both for the problem of evolution of galaxies and for the study of the properties of pre-stellar matter.

Viktor Amazaspovich Ambartsumian, as founder and director of the School of Theoretical Astrophysics in the USSR, president of the Academy of Sciences of Armenia, and president of the International Astronomical Union, has made a noted contribution to science in the Soviet Union and affected the growth of scientific knowledge throughout the world. (Source: ICSU Review of World Science, Vol. 5 (1963))

EAST MEETS WEST VIA TELSTAR 2. The second Telstar satellite has been successfully tracked by a Japanese ground station near Tokyo. The Bell System's communications satellite was followed for a period of 18 min on July 7 at distances from 14,000 to 15,000 km (8981 to 9268 statute mi) from Japan; it was in a similar position for tracking shortly after midnight (EDT) July 8.

The Japanese pointed their antenna at the satellite as it rose above the Pacific Ocean near Hawaii and headed toward the continental United States. The ground station at Andover, Maine, turned on the communications equipment in the satellite, and then the satellite's microwave beacon signal was picked up by the Japanese antenna. There were no communications tests conducted.

Tracking exercises between Andover and Tokyo were expected to continue through July 20. Successful tracking exercises require that the satellite be a few deg above the horizon at both ground stations so that Andover can turn the satellite on and Tokyo can receive the beacon. Mutual visibility periods will occur through the summer months, after which there will be no more mutual visibility until next April. Then the satellite will be mutually visible again for about 2-1/2 mo.

According to Kokusai Denshin Denwa Co. Ltd. (KDD), the Japanese company responsible for the ground station, it will be ready to conduct full scale communications experiments during the next period of mutual visibility, beginning in April 1964. (Source: Bell Laboratories News Release, July 9, 1963)

SOVIETS COMPLETE PACIFIC OCEAN SHOTS. The official Soviet news agency (TASS) announced that the Soviet Union had completed its rocket firings into the Pacific Ocean as of July 11. According to the announcement, the rocket launches and operations of on-board instrumentation proceeded precisely according to schedule.

The area released to international shipping and aerial flights has the following coordinates:

Northern latitudes	Eastern Longitudes
35 deg 23 min	173 deg 52 min
33 deg 10 min	175 deg 24 min
32 deg 08 min	173 deg 56 min
34 deg 21 min	172 deg 23 min

(Source: Red Star, July 11, 1963)

COMMUNIST CHINESE RECOGNIZE IMPORTANCE OF SCIENTIFIC PUBLICATIONS. The National Scientific and Technological Commission and the Ministry of Culture announced on June 26 that Communist China will take immediate steps to increase the number, variety, and quality of scientific and technical publications to meet its growing needs in this field.

The joint conference recommended that scientists and technicians write new works and that older works be brought up to date. (Source: The New York Times, July 18, 1963)

FROM THE SEMITECHNICAL LITERATURE

ROCKETS AGAINST HAIL. Detailed information on the Soviet Union's efforts to control the weather has been announced. Brief reports of these efforts were given in the May 1962 and January 1963 issues of Space Intelligence Notes.

In the Russian village of Ruispir, near the peaks of the Great Caucasus Mountains, the Soviets have established a weather center that employs modern radar and rockets to prevent hail damage to their vineyards. On several of the 2000-m (6000-ft) mountains surrounding the Alazan Valley, the Soviets have placed rocket launchers and radar stations under the control of the Geophysical Institute of the Georgian Academy of Sciences and the Central Aerological Observatory of the Main Administration of the Hydrometeorological Service (Gradograd) under the Soviet of Ministers USSR.

At the beginning, it was necessary to study the physics of hail formation and cloud formation and to acquire the ability to gauge the processes of hail formation and shower potential of the clouds. This was followed by the investigation of elements, which when introduced into cloud formations by the explosive head, would precipitate hail showers in designated areas of the mountains.

Following the decision to employ rockets in this program, a special portable rocket was devised, and intensive testing began in 1958. This produced such favorable results that a hail defense service was established in the Alazan Valley with forty rocket positions and supplementary radar installations.

The original rocket equipment is now in the process of being replaced by more powerful rockets, 2 m (6-1/2 ft) long and weighing "several tens" of kg. Utilization of the more powerful rockets, which resemble the famous artillery "Katusha," permits their installation in more easily accessible hills and helps to conserve manpower. (Source: Red Star, July 14, 1963)

FROM THE TECHNICAL LITERATURE

COMMUNICATIONS

SPACE TELEVISION. I. Aleksandrov, a leading Russian specialist in the field of television, stated in a recent interview that radio communications over enormous distances have already been accomplished with the support of special transmitters, highly sensitive receivers, and highly directional antennas. Aleksandrov stated that the Soviet television standard for picture definition is taken as 625 lines, each consisting of 833 smaller picture elements and sent at 25 frames per sec. He further stated that the higher the picture definition of a telecast from space, the greater the power consumed. Thus a power source many times the weight of the spacecraft would be required to obtain standard definition in such pictures. For the Vostok 3 and Vostok 4 flights, images were televised at 10 frames per sec with each frame broken into 400 lines.

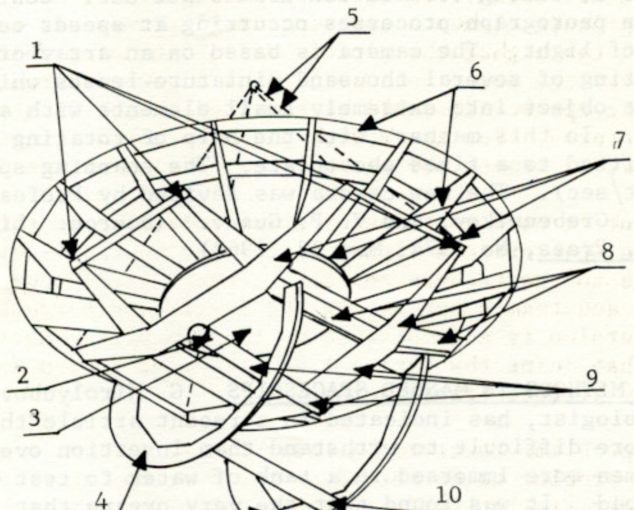
Special equipment is used to transfer space telecasts to the nationwide TV network. The spacecraft's signal is relayed by radio-observer receiving stations to the television center, where it is converted to the number of lines and frames per sec of the Soviet and European standards. The signal conversion is accomplished by the use of a camera at the television center that scans the "space line" receiver screen and then carries out its ordinary picture transmission.

There are many problems involved in launching TV equipment for space exploration. One problem to be solved is the development of a camera capable of operation under fickle lighting conditions. To reap the greatest benefits in space communication would require the launching of an actual TV station. This could be made possible only by utilizing the latest achievements in electronics technology.

Aleksandrov concluded the interview by stating that space television, which had its inception in the photographing of the dark side of the Moon, is developing successfully and promises one of the greatest means for understanding the Universe. (Source: Library of Congress, A.I.D. Press, Vol. 2, No. 8, July 11, 1963)

SOVIETS CONSTRUCT NEW PARABOLIC ANTENNA. The construction of a rigid large-dia parabolic antenna has been proposed to minimize disk distortion caused by static deflection at various antenna attitudes.

As a theoretical example, a 66-m (217-ft) -dia reflector is assumed, which is not to impose over ±3-mm (±0.1-in.) static deflection. Simulating an arrangement of supports in which the distance from the disk edge to an outer support does not exceed 4-5 m (13-16 ft) and the distance between supports is from 10 to 14 m (33 to 46 ft), a total of 17 support members is necessary. These are arranged in a main outer and auxiliary inner circle of supports plus one central member, as shown in the illustration. Load members (9) from the inner circle converge symmetrically at the center of counterweight beam (10) and are rigid enough to affect a negligible deflection on the plane of the inner support points under any antenna position.



1. Main support points
2. Trunnion
3. Central support
4. Rotating sectors
5. Feed element supports
6. Reflector framework
7. Auxiliary support points
8. Intermediate support structure
9. Eight-member support pyramid
10. Counterweight beam

Distortion in the outer support circles is accomplished by the adjustment of the counterweight load moment as a function of elevation position. To maintain a given degree of parabolicity for any elevation of the antenna, the convergence point of load members (9) is automatically shifted along the counterweight beam as required. (The plane of the outer support points is parallel to that of the inner points.) (Source: Library of Congress, <u>A.I.D. Press</u>, Vol. 2, No. 13, July 18, 1963)

LASERS

CRYSTAL LASER. The Institute for Applied Physics at the University of Vienna (Austria) is currently building a crystal laser to be used for basic research in optics.

This study is being conducted in particular to establish the effect of laser rays in research of crystal composition. (Source: V.D.I. Nachrichten, June 26, 1963)

PHOTOGRAPHY

HIGH SPEED CAMERA DEVELOPED. According to the May 15, 1963 issue of Pravda, the Leningrad Institute of Motion Picture Engineers has developed a camera capable of taking 500 million frames per sec. Designated the "PKC-2," it can photograph processes occurring at speeds comparable only with the speed of light. The camera is based on an array of small optical scanners consisting of several thousand miniature lenses which break down the image of the object into extremely small elements with a dia of hundredths of a mm. In this manner, with the help of rotating mirrors, the image is transmitted to a fixed photoplate. The scanning speed is 15,000 m/sec (48,000 ft/sec). The new camera was devised by Professor S. M. Provornov, O. F. Grebennikov, and V. P. Gusev. (Source: Library of Congress, A.I.D. Press, No. 974, May 22, 1963)

SPACE FLIGHT

SHOCK ABSORBING METHODS IN MANNED SPACESHIPS. G. Mirolyubov, a Soviet physician-physiologist, has indicated in a recent article that reentry overloads are more difficult to withstand than insertion overloads. In an experiment, men were immersed in a tank of water to test man's ability to resist overload. It was found that the very organs that resist overload were affected: muscle tonus and strength were reduced, and cardiovascular activity was sharply disrupted. Thus it is necessary to be completely accurate in determining overload forces in reentry.

The possibility of landing a cosmonaut in the cabin, using the cabin as protection against, cold, heat, and the open sea, has been examined. When a spaceship lands on the ground, an 0.1-sec overload occurs. This is sufficient to cause injury; therefore, shock-absorbing methods must be devised. Many experiments in impact overloads have shown that man's heartbeat and breathing quicken and his blood pressure rises, which indicate an adaptation reaction in the organism. Films taken at 300 to 400 frames/sec showed that at the moment of impact a man is unable to maintain an assumed pose. The head and the shoulder girdle compress perceptibly as a result of elastic deformation. Proper positioning of the pilot in his seat lessens the amount of compression and aids in the withstanding of overloads.

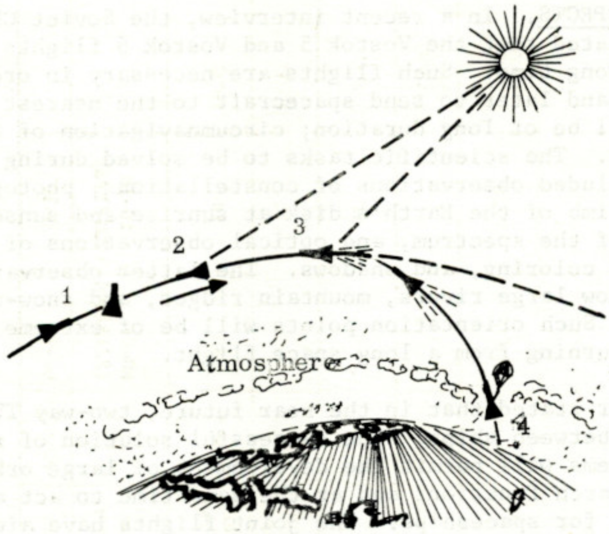
Various methods for protecting the organism from shock overloads have been examined. The system of the suspension of a man in water as a means of overload protection is comparable to a well-fitted system of restraining straps, which does not have the disadvantages of hydraulic shock. Mirolyubov stated, however, that hydraulic shock can be avoided through the use of a suit made of microporous air-foam rubber. Animals in such suits have withstood without injury the shock of dropping 8 m (26 ft) onto a metal plate. Solid armor increases resistance to impact even more. Animals [encased] in plaster have withstood impacts with solid ground after a 13-m (42-ft) fall. In this instance, overloads exceeded tolerable limits by 10 times. (Source: Library of Congress, A.I.D. Press, Vol. 2, No. 9, July 12, 1963)

SPACE FLIGHT PROSPECTS. In a recent interview, the Soviet Chief Spacecraft Designer stated that the Vostok 5 and Vostok 6 flights were calculated to last a long time. Such flights are necessary in order to build orbital stations and later to send spacecraft to the nearest planets. These flights will be of long duration; circumnavigation of the Moon will take 8 to 12 days. The scientific tasks to be solved during the Vostok 5 and 6 flights included observations of constellations, photographing of the Sun and the limb of the Earth's disk at sunrise and sunset and in various regions of the spectrum, and optical observations of the land, seas, the Earth's coloring, and shadows. The latter observations are for determining how large rivers, mountain ridges, and snow-covered peaks look from space. Such orientation points will be of extreme importance to cosmonauts returning from a long space flight.

The Chief Designer stated that in the near future, two-way TV communications will exist between ships. The successful solution of rendezvous and docking problems will permit the development of large orbital stations to carry out research functions and at the same time to act as docking and supply points for spaceships. The joint flights have aided in the solution of this problem. At present, the spaceships fly along so-called self-decelerating orbits; that is, in the event of retro-unit failure, the movement of the ship is slowed by atmospheric drag, and the ship descends to Earth in a comparatively short period. The existence of docking stations and the possibility of joining ships together will permit the use of higher orbits. (Source: Library of Congress, A.I.D. Press, Vol. 2, No. 10, July 15, 1963)

SPACECRAFT HEATING AND REENTRY. According to K. Malyutin, the kinetic energy of a Vostok-type spacecraft weighing 5 tons as it approaches the atmosphere is equivalent to 400 to 500 fifty-car freight trains traveling at a rate of 70 km/hr (43 mi/hr). Although the deceleration system significantly decreases velocity, the ship's skin and nose are subjected to intense kinetic heating that can exceed 1000°C (1850°F). Since no single material can completely satisfy the complex requirements of heat resistance and strength, the skin of a spaceship is laminated with fiberglass, high-temperature phenolic resins, and ceramic coatings in addition to the basic alloy.

A spaceship returning from the Moon will travel at a velocity approximating second cosmic speed as it approaches the Earth. From the elliptical Moon trajectory and the subsequent flight around the Earth, the spacecraft must enter into an Earth orbit preceded by a decrease in velocity to 8 km/sec (4.9 mi/hr). The velocity can be reduced aerodynamically by skipping the craft off the denser layers of atmosphere until it enters a circular orbit at the velocity desired. The diagram shows the approximate sequence of a spaceship's descent.



1. Orbital flight
2. Orientation with relation to the Sun
3. Cut-in of retro engines
4. Descent of ship

(Source: Library of Congress, A.I.D. Press, No. 974, May 22, 1962)

DETAILS ON VOSTOK 5 AND VOSTOK 6. Krasnaya zvezda has reported in various sources that the Vostok 5, launched at 3 P.M. Moscow time on June 14, 1963, completed more than 81 orbital passes and spent more than 119 hr in space. The spacecraft traveled more than 3,300,000 km (2 million mi) and landed at 14:06 P.M. June 19, at a point along the 58° parallel, 540 km (330 mi) NW of the city of Karaganda. The Vostok 6, launched at 12:30 P.M. on June 16, 1963, completed more than 48 orbital passes and spent more than 71 hr in space. The Vostok 6 traveled approximately 2,000,000 km (1,250,000 mi) and landed at 11:20 A.M. June 19, at a point

VOSTOK 5 AND VOSTOK 6 FLIGHTS (USSR)

Date	Perigee	Apogee	Period	Pulse asleep	Pulse awake	Respiration awake	Cabin Temperature	Cabin Pressure	Relative cabin humidity
14 June 1963*[1]	175 km (2212 hrs)	222 km (2212 hrs)	88. 27 min (2212 hrs)		76	24			
15 June 1963*[2]	173 km (1500 hrs)	219 km (1500 hrs)	88. 2 min (1500 hrs)	48–56	60–70	17–20	20° C (0005 hrs)	775–780 mm Hg	40–60%
16 June 1963[3,4] V–5	168. 4 km	208. 3 km	88. 06 min	50–56			14–16° C	780 mm Hg	55–60%
16 June 1963[3,4] V–6	181 km (2200 hrs)	231 km (2200 hrs)	88. 3 min (2200 hrs)		80	20	23. 6° C	754–770 mm hg	34%
17 June 1963[5] V–5	165 km (1500 hrs)	202 km (1500 hrs)	88. 0 min (1500 hrs)	46–50	60	15	15° C		
17 June 1963[5] V–6	177 km (1500 hrs)	225 km (1500 hrs)	88. 2 min (1500 hrs)	52–54	68	18	18° C		
18 June 1963[6] V–5	159 km (1500 hrs)	193 km (1500 hrs)	87. 8 min (1500 hrs)	45–52	60–58 (2218 hrs)	16–18 (2218 hrs)			
18 June 1963[6] V–6	174 km	218 km	88. 1 min	52–60	64–76	18–20			

*) Dates marked with an asterisk refer only to Vostok 5 flight.
All times mentioned in this article refer to Moscow time.

along the 58° parallel, 620 km (380 mi) NE of the city of Karaganda. During their flights, the Vostok 5 and Vostok 6 came within approximately 5 km (3 mi) of each other at the closest point in their orbits. (Source: Library of Congress, A.I.D. Press, Vol. 2, No. 5, July 8, 1963)

SCIENCE AND TECHNOLOGY SECTION TRANSLATIONS

The following article was selected and translated from current Soviet literature by the Science and Technology Section.

"Physical Conditions on Mars" by N. P. Barabashov, Member of the Academy of Sciences USSR.

Mars is one of our neighboring planets. From the time of Galileo, or more than 350 yr ago, astronomers have been directing their telescopes towards Mars and have been observing phenomena on its surface and in its atmosphere.

Recently, for the observation of planets, utilization has been made of photometers, spectroscopes, polarimeter, radiometer, and radio-observation. As a result, it has been possible to compile a sufficiently clear presentation of the basic singularities of Mars, although a series of manifestations observed from Earth have not as yet been completely interpreted. These are more or less similarly commented upon, although heated discussions often arise among many astronomers.

An attempt will be made to clarify what we know reliably about Mars, what remains in the area of more or less reliable assumptions, and, finally, that which is presently completely unexplainable.

It is well known that even with weak telescopes it is possible to observe very clearly the large orange areas on Mars that are called continents, which contain fairly dark areas designated as oceans. Besides this, near the poles of Mars there were discovered light areas that change their dimensions with the seasons and are called polar caps. The continents of Mars are intersected by numerous dark lines, which closely resemble arcs of large circles. These belts have been called canals. The canals connect seas or darker formations, which are called bays, lakes, and oases. "Canals" are even found in the oceans.

The presence of all of these formations arouses doubt in no one, but their strata arouse various opinions.

What do we know about the formation of continents of Mars? Telescopic observation demonstrates that the continental surface is even and smooth, almost completely devoid of macrorelief. There are neither high mountains nor any extensive mountain ranges. If there were any elevations reaching 400-500 m (1300-1600 ft), they would be located definitely by their shadows. Only at the southern pole of Mars have mountains been observed. These are called Mitchell mountains.

Aided by photometric measurements, accomplished through the variously colored light filters, scientists have found evidence of the macrorelief features on the surface of Mars' continents. In red and near-infrared rays, distribution of the brightness on Mars' disk (on the continents) from the center to the edge is in agreement with Lambert's law of reflection, which is excellent for an ideal dull surface with irregularities less than 0.1 mm (0.004 in.).

Such a conclusion is reached if one departs from the completely natural assumption that the rarefaction of Mars' atmosphere has a slight optical thickness and possesses basically, similar to Earth, diffusing matter; at the same time, the role of the actual absorption by it is not very great. A similar opinion is maintained by the majority of astronomers studying Mars.

In accordance with the transition to the shorter wave lengths--blue and ultraviolet--the diffusion constantly increases, and the contrast between the light and dark areas on Mars' disk becomes shaded.

Let us assume that the continents of Mars reflect light in accordance with Lambert's law and that Mars' atmosphere basically possesses diffused matter. Then the coefficient of transparency R in Mars' atmosphere (as the average of the calculations of N. P. Barabashov, N. N. Sytinski, V. G. Fesenkov, and V. V. Sharonov) will be $R_{kr} = 0.975$, $R_{sin} = 0.908$, $R_{uf} = 0.842$, which correspond to the optical thicknesses $\tau_{kr} = 0.021$, $\tau_{sin} = 0.085$, and $\tau_{uf} = 0.132$.

These values are received in accordance with the formulas of V.V. Sobolev, N. N. Sytinski, and V. G. Fesenkov. The pressure of Mars' atmosphere as computed by N. P. Barabashov, N. N. Sytinski, Z. H. Vokuler, and others consists on the average of 6-8 cm (2.4-3.2 in.) of the mercury column; that is, it corresponds primarily to 1/10 of the Earth's atmospheric pressure.

From this more or less accurate reconstruction of the atmosphere and surface of Mars, it follows that the reddish color of its continents is produced by its covering of minute reddish dust, obviously containing iron oxides.

On the basis of the author's last observations and other studies, it is possible to conclude that the traces covering the oceans and continents of Mars resemble closely such Earthly rocks as the reddish and greatly crumbled volcanic tufas, as well as limonite, ocher, and reddish sandstone, according to their spectral, photometric, and polarization characteristics.

It is interesting to note that when λ = 560 mmk, i.e., in the green portion of the spectrum, then the crumbled tufas have a noticeable decrease in brightness in comparison with the oceans on Mars at a time when other long waves have a less noticeable decrease in radiation. On the continents a comparable manifestation is not observed.

Thus if the continents and oceans on Mars consist of crumbled tufas, then a somewhat greenish component is added to the basic color of the oceans. From here it is possible to conclude that the oceans and lands on Mars may consist of the same rocks although in different phases of oxidation.

The strong decrease in contrast along the spectrum between the oceans and the continents may be a basic consequence of the spectral reflective qualities of the rocks, which enter into their composition, and does not signify a considerable optical thickness of the atmosphere. In this case, our observation of a pattern with slight optical thicknesses τ is confirmed.

N. A. Kozyrev, on the basis of spectro-photometric observations of Mars, concluded that the significance of the true brightness of the continents $\overline{I}$ and oceans I_1– (λ) may be associated with the ratio $\overline{I}(\lambda) = KI_1(\lambda)$, when K- the relationship between the brightness of the continent and the brightness of the ocean equals 2.5 at 640 mm (25.19 in.) of pressure. According to the judgement of N. A. Kozyrev, the reddish color of Mars can be attributed solely to the elements in its atmosphere, where the absorption exceeds the dispersion. For the optical thickness he finds that $\tau_{kr} = 0.10$, $\tau_{sin} = 1.38$, which is a very large value.

According to Kozyrev, the surface of Mars is not colored and is practically neutral--a grey.

E. Eöik believes that the surface of Mars reflects light not in accordance with the law of cosines but by a law that is applicable for the Moon. He likewise assumes that the macrorelief of Mars' surface is analogous with the Moon's. Hence he assumes that if Mars is devoid of an atmosphere, then, when the angle of a phase equals zero, the brightness of its disk (with a similar albedo in various locations on the disks) would be similar, and a reduction from the center to the edge would not be noticeable.

Having utilized the formulas of N. N. Sytinski and V. G. Fesenkov, E. Eöik calculated the albedo of the surface of Mars from various rays of the spectrum and the coefficient of the transparency of its atmosphere. The values determined by him compel one to reckon that almost always in the atmosphere of Mars there is suspended absorbed light from particles and that the diffusion is nearly seven times less than the actual absorbtion in ultraviolet, which is very inadmissible. Besides this, the large albedo of the surface of the planet is quite improbable since it exceeds the albedos of many mountain strata and agrees only with the brightest ones.

The hypotheses of N. A. Kozyrev and E. Eöik are quite artificial. Hence it is sensible to accept our conclusion that the atmosphere of Mars possesses a small optical thickness; that the decrease in contrast towards the blue end of the spectrum is basically explained by the components in its covering; and that the surface of Mars is covered by a minute dust of a reddish color. In support of the dust cover, the yellow clouds often observed on Mars, which conceal details of its surface, offer graphic evidence. As is known, these "dust storms" were especially violent during the period of the great opposition in 1956. Similar conclusions are reached by A. Dolfus in the basic analysis of the polarimetric observations. Concerning the strata in the oceans of Mars, there is no single opinion.

Some of the observers consider that the oceans are the more humid areas of the surface where some type of Martian vegetation exists. According to the opinion of others (for example, the American astronomer D. V. MacLaflin), active volcanoes, which eject volcanic ash, exist on Mars; and the oceans are considered large volcanic deposits. The volcanoes themselves are located in the tops of triangular gulfs. According to MacLaflin, the form and arrangement of the areas occupied by the dust are determined by the direction of the winds blowing on Mars. So far, this hypothesis is unproven.

We will now direct our attention to the structure of the atmosphere on Mars. All observations that have been conducted up to this time attest to the possibility of oxygen existing in Mars' atmosphere, although in very insignificant quantity, on the order of 0.1 per cent of its existence in the Earth's atmosphere. The composition of Mars' atmosphere is unknown to us. With the certitude of the spectroscopic method, the presence of carbon dioxide on Mars has been revealed. George Koiper, who was the first to establish the presence of absorbtion belts of CO_2 in the infrared portion of the spectrum of Mars, rated its percentage as twice the quantity of CO_2 in the Earth's atmosphere. Z. H. Grendzhen and R. Gudi, who conducted a theoretical investigation into the effect of pressure, concluded that the content of CO_2 in Mars' atmosphere exceeds the content in the Earth's atmosphere thirteen times.

Photometric observation compels one to think that there should be other gases on Mars, possibly nitrogen with an addition of argon or other gases.

The French astronomer Z. H. Vokuler presents this view of the actual structure of the Martian atmosphere in comparison with that of the Earth's:

Content According to Volume (V%)

Gas	Mars	Earth
N_2	98.5	78.08
O_2	<0.1	20.94
A_R	1.2?	0.94
CO_2	0.25	0.03

American astronomers S. S. Kis, S. Karrer, and N. K. Kis assume that Mars' atmosphere is twice as rich in carbon dioxide as the Earth's, even though the belt of CO_2 may belong to NO_2. According to their opinion, Mars possesses both NO_2 and N_2O_4 as well as NO; the pressure of N_2O_4 on Mars is on the order of 140 mm (5.51 in.); the yellow clouds on Mars are masses of NO_2 in great concentrations. The transparent trioxide of nitrogen breaks down into a dioxide with its characteristic yellow color. When the temperature drops, the molecules of NO_2 recombine into N_2O_4, and the yellow color disappears.

The red color of Mars and its albedo is explained by the American scientists as the optical qualities of the peroxidation of nitrogen. When the temperature falls, a sufficiently rapid polymerization of NO_2 into N_2O_4 occurs, which results in the appearance of an "azure clearing." An increase in the quantity of NO or N_2O_3 in a mixture with N_2O_4 and NO_2 imparts an azure color in clouds, as described by N. Rait and F. E. Rosso. The polar caps may be composed from a hard peroxidation of nitrogen N_2O_4 in temperatures less than -40°C (-40°F) (at which time it has a white color). With a decrease in temperature in the hard phase, NO and N_2O_3 are added, which impart an azure and green shading to the caps. In temperatures higher than -40°C (-40°F), NO_2 appears, and the caps acquire a yellowish color.

A dark border around the caps, as proposed by the American astronomers, represents a brownish solution of NO_2 in a liquid N_2O_4. Together with brownish tones a greenish one may also appear because of the interaction of HNO_3 with minerals or because of the addition of NO and N_2O_2.

In the opinion of the previously mentioned authors, life on Mars is impossible because of the toxicity of the nitrogen oxides. However such a view cannot be considered sufficiently substantial, all the more so because the changes associated with the decomposition and recombination of nitrogen oxides under Martian conditions apparently may have no function.

Water vapor in Mars' atmosphere is in an insignificant volume as far as it has been possible to detect. This has been exhibited only by the polar caps, light-colored clouds, and the fogs in the evenings and mornings observed on Mars.

However, a small quantity of water vapor in Mars' atmosphere is not manifested, as demonstrated by the Soviet astronomer A. I. Lebedinskiy, because of the absence on Mars of large quantities of frozen water--subsoil ice covered by a layer of dust.

On the basis of the known dimensions of the vapor effect on Mars and the known percentage of carbon dioxide, K. Segen rated the water vapor in Mars' atmosphere as being 0.02-0.002 g/cm^2 (0.005-0.0005 $oz/in.^2$) of surface. K. Segen believes that the water vapor may be detected directly if the sensitivity of the infrared spectroscope increases ten times and if the observations are conducted sufficiently high above the Earth's surface.

Regarding temperatures on Mars, sufficiently good information exists. Measurements conducted at the Lovellovski Observatory have demonstrated that on the equator of Mars at 7 hr 42 min local solar time, the temperature was -38°C (-36.4°F). By 11 hr 30 min it was measured at 0°; by midday it reached +3°C (+37.4°F) and attained its maximum of +7°C (+44.6°F) at 13 hr 18 min; and at 16 hr 24 min it decreased to -18°C (-0.4°F); and finally at 18 hr it became -48°C (-54.4°F).

New measurements made by V. M. Sinton on a 5080-mm (200-in.) reflector give basically the same views. Besides this it was announced that the oceans are warmer than the continents on an average of 10-15 deg with the temperature reaching +37°C (+98.6°F) at the warmest place. At the present time there are sufficient detailed isotherms for the various seasons. In 1950, S. Gess compiled a general map for temperature circulation on Mars although it still requires considerable correction.

Pressure and Density of the Atmospheres on Earth and Mars

Altitude in km	Pressure in Millibars		Density ($10^5 \rho$) g/cm^3 (oz/in.^{3})	
	Earth	Mars	Earth	Mars
0	1013.3	75	120 (69)	10 (5.78)
4	600	57	79 (46)	8 (4.62)
8	277	50	52 (30)	7.5 (4.34)
12	180	40	30 (17)	6.3 (3.64)
16	107	35	17 (9.8)	5.5 (3.18)
20	64	25	9.3 (5.4)	5 (2.89)
24	30	21	4.8 (2.8)	4 (2.31)
28	15	18	2.6 (1.5)	3.5 (2.02)

The density of Mars' atmosphere and its pressure must decline with height as is the case on Earth. Accepting an acceleration of the strength of gravity on the surface of Mars equal to 0.38 per cent of the Earth's acceleration and assuming that Mars' atmosphere consists basically of molecular nitrogen with a constant temperature around 50°C (122°F), Z. H. Vokuler determined the variation in pressure in relation to the altitude.

He found that the pressure decreases ten times for each 40 km (25 mi) of altitude. On Earth the same decrease corresponds in 16-17 km (9.9-10.5 mi). From this we conclude that at an altitude of 28 km (17.3 mi) the atmospheric pressure on Earth and Mars is similar. From this it follows that our propeller-driven airplanes could accomplish flights on Mars and rise to a greater altitude than on Earth.

Radio observations of Mars made by means of a 15-m (49.2-ft) radio telescope on a wave $\lambda = 3$ cm (1.1 in.) demonstrated that the average temperature of the planet is somewhat lower than 0°. This agrees with data from radiometric calculations and shows that the radiation emanates immediately from the planet's surface.

S. Gess, who does not consider Mars' temperature as being constant, determined the variations in pressure and density of Mars in relation to the altitude (see table). The data shown by him differ little from that determined by Z. H. Vokuler.

We may consider that at an altitude of 45 km (27.9 mi) above Mars' surface, the temperature decreases to 160°C (320°F) and then rises to and remains at a more or less constant value of -100°C (-148°F).

The opaqueness of Mars' atmosphere in short wave length is explained by G. P. Kriper as the result of the gases SO_2, NO, N_2O, CO_5 having thresholds of a photo-chemical dissociation when $\lambda = 0.2$ mk. If this is true, then the atmosphere of Mars should be almost opaque for waves $\lambda < 0.2$ mk.

At the northern and southern poles of Mars, bright manifestations--polar caps--are observed. The dimensions of their surfaces are subject to seasonal changes. The caps have a maximum size in the winter and progress towards the minimum and even occasionally disappear soon after the end of summer with respect to the hemisphere. At the end of winter the polar caps normally occupy an area up to 10 million km^2 (3.8 million mi^2). At that time the area stretches to the 50° aerographic latitude. In proportion to the decrease of the polar cap, even brighter spots appear on it. It disintegrates into individual parts which regularly disappear; it remains only for extended periods near the southern pole. Here, apparently, the rime or frost remains on the top of the plateaus or slopes of the Mitchell mountains.

The polar cold weather on Mars as on the Earth does not coincide with the aerographic belt but is situated 400 km (249 mi) away in relation to it. Our observations show that the polar caps are not azure or greenish, as described by some astronomers, but are a light reddish color. We believe that the matter composing the polar caps covers Mars' surface with spots, among which can be seen the reddish land, rather than by a continuous layer. Our colormetric observations also indicate that the polar caps obviously consist of two components: the surface--from snow, frozen or rime--and the atmosphere--from fog or light clouds. Occasionally both components are seen, sometimes only one, and occasionally both disappear.

Investigating the infrared area of the spectrum of the polar caps, G. P. Koiper came to the conclusion that they consist of frozen water. Polarimetric observations of B. Lio indicate that clouds often form over the polar caps. In respect to the thickness of the covering of the polar caps, it cannot exceed several cm. This is also indicated by the rapid decrease in the dimensions of the polar caps as shown by the thawing, which occasionally reaches 100 km (62 mi) in a day. However, the normal thawing proceeds slower--from 10-20 km (6-12 mi) per day.

Besides the dust clouds, bright cloud formations, obviously formed from small ice crystals, are quite often observed in Mars' atmosphere. Morning and evening fogs, as shown during the illumination of the morning and evening areas on the disk of the planet, are especially observed frequently. Through the transposition of cloud formations we were able to explain that they move about the disk of Mars with a speed of 15 to 40 km per hr (10 to 25 mph). A similar wind speed probably also exists at an altitude of several km above Mars' surface. In regard to the thickness of clouds, if they are similar to the high clouds on Earth, we assume that their thickness should not exceed 3-10 m (10-32 ft). Quite often on Mars hard precipitation appears, which occasionally covers a considerable area. Probably it is rime that settles on the surface.

During the opposition of Mars in 1877, an Italian astronomer, G. V. Skiaparelli, detected on it a network of narrow dark belts, which, on occasion, seemed to him to be double and which dissected in various directions the orange-reddish areas of the planet. He called these belts "canals." At the present time several hundred canals have been detected. They always start in the oceans, not on land, and connect large dark spots--oceans--and smaller spots--islands and oases. There, where several canals meet, dark specks--knots--are observed. Canals have also been noticed in the Martian oceans.

What is the significance of the canals?

Some of the scientists believe that they are fissures in the tectonic origin of the core of Mars; others consider them as accumulations of a multitude of undefinable components or see them as more humid places when spring and summer vegetation appears.

Many observers, G. V. Skiaparelli, L. Lovell, K. Flammarion, and others, maintain that the canals represent unbroken long lines that extended for very long distances, frequently thousands of km. Other observers, for example, E. Antoniadi, consider that the canals were an aggregate of a multitude of small dark specks that human eyes unite into straight lines because of the great distance of Mars from Earth. Individual canals undoubtedly are borders between the more light and dark areas of Mars' surface. Maps of Mars in considerable detail, including canals, oceans, and lakes, have been made.

To resolve the controversy over the canals and for a more detailed study of Mars' surface, the French scientists A. Dolfus, K. H. Komishel, and others conducted a series of various observations at the observatory of Pik-Du-Midi in the Pyrenees mountains at an altitude of 2870 m (9416 ft) above sea level. Many canals were photographed. It should also be mentioned that many photographs were obtained by G. A. Tukhov in Pulkov earlier in 1909.

Comparing the observations at Pik-Du-Midi with the Parisian, A. Dolfus concluded that on the surface of Mars there are irregular spots that are variously grouped. Occasionally they are situated along straight lines. Another type of canal--thread-like and also geometrically straight--was discovered. They are relatively short and frequently appear double.

Unusually interesting were the observer's remarks concerning the seasonal changes. Many canals were almost unnoticeable in the hemisphere having winter weather. With the coming of spring the canals appear directly adjacent to the thawing polar caps. Afterwards canals become visible in the temperate belt, and finally, canals in the equatorial belt. After 6 mo these canals disappear, but then in another hemisphere, from the polar caps to the equator, a counter wave of a darkening of canals begins to spread. It is possible that even though the canals are in general invisible from Earth due to their narrowness, the dampness following the thawing of polar caps encourages the growth of some type of vegetation around them. This agrees with the fact that the darkening of the canals begins immediately after the beginning of the thawing--14-15 days later. Further, in the winter when the canals are invisible, the oases seem very small, scarcely visible dots; however, in summer they enlarge visibly, especially if several canals join.

How is it possible to explain these seasonal changes in the canals and oases of Mars except for the appearance of vegetation?

Is there some type of life on Mars? At the present time it is necessary to answer that question obviously in the affirmative, especially since photometric, polarimetric, radiometric, spectroscopic observations, and other studies confirm such a conclusion. First, if the oceans were not covered by vegetation, then as concluded by N. Kucherov and E. Eöik, the yellow dust of the Martian deserts would fill them quickly, and then they would compare in color and brightness with the continents. If we assume that the dust is shaken off by the upper parts of the vegetation and falls between it, then such an observation would not be possible. The opinion of G. P. Koiper--that the dust simply may be blown off by the winds--

is not very accurate. Seasonal changes in the canals and oases also affirm the existence of growing cover. In the opinion of A. Dolfus the variation in polarization during the changes of seasons on Mars demonstrates that the structure of the covering changes parallel with the coloring, which is explained easiest by the growth of microscopic seaweeds. N. P. Barabashov demonstrates that in several of the Martian oceans, the appearance of a greenish color is observed, which changes to a brownish hue later in the autumn and into grey in the wintertime.

V. M. Sinton, assisted by a 5080-mm (200-in.) reflector at the observatory at Mt. Palomar, studied the infrared region of Mars' spectrum and found in the spectrum of the oceans three belts of absorbtion: 3.43, 3.56, and 3.67 mk belonging to the connection C-H. These belts are detected only in the spectrum of the oceans, namely in the Mare Cimmerium, Mare Syrenum, Pandorae Fretum, and Syrtis Major. It is not probable that these belts should pertain to inorganic molecules. Obviously, they pertain to organic molecules of some type of Martian vegetation. It is interesting that in these areas we have noticed seasonal changes in coloration, spring and summer changing into a greenish hue.

The belts are very noticeable when $\lambda = 3.67$ mk. V. M. Sinton found seaweeds among some of the lichen. The molecules H_2O, CH_4, and N_2O were not noticed by him in Mars' spectrum. All of this compels one to accept the presence of organic life on Mars as sufficiently substantiated.

What remains to be undertaken in order to significantly increase our knowledge of Mars and thus assist future cosmonauts who will depart toward that planet? First of all, the observation of Mars should be conducted by means of the most powerful of our instruments in an orderly and not sporadic manner during an extended period, so that it would be possible to follow daily and seasonal changes on Mars. This is absolutely necessary to explain the physical conditions or Mars.

Further, it is necessary to coordinate the work at various observatories in order to obtain the greatest possible interval of time during a single day and similarly to review the largest possible portion of the planet along its longitude during one night. It is necessary to develop various photometric and spectroscopic observations and to progress in both infrared and ultraviolet areas of the spectrum.

Accurate radiometric and polarimetric observations are likewise extremely valuable. The study of the relationship of the monochromatic brightness of the light and dark formations on Mars especially from 0.2 to 5 mk is exceedingly valuable. Toward this objective it is necessary to add the study of the radio radiation of Mars for various wave lengths, as well as optical laboratory and other studies of minerals and mountain strata.

In conclusion, our launching of an automatic station and cosmic ships equipped with scientific instrumentation toward Mars will be of inestimable value in the clarification of the singularities of the physical nature of Mars. However, the crowning achievement will be the landing of man on its surface. (Source: Vestnik Akademii Nauk SSSR (USSR Academy of Sciences Journal), No. 10, October 1962)

BOOKS

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

Slager, Ursula T., Space Medicine. Published by Prentice-Hall International, London, 1963. Reviewed by Sq. Ldr. Peter Howard.

Space medicine is a peculiar and unbalanced mixture of other sciences. Physiology, engineering, physics, and psychology all contribute to it, and its name is justified only by the fact that it has to do with people. Its connection with clinical science is remote, for it is concerned not with diseases, but with experimental situations. The stresses likely to be encountered by astronauts and cosmonauts, and the means of protection against those stresses, provide its subject matter. The tools of space medicine are not the stethoscope and the tendon hammer (though these may play their part), but the decompression chamber, the centrifuge, and the flight simulator. Within the past two years, the results obtained in the laboratory have been confirmed or contradicted in space capsules, and the practical achievements of manned space flight have brought an increasing interest in the biological problems associated with it. This interest is reflected in the rate at which new books on the subject of space medicine appear, and by the diverse qualifications of their authors.

The book under review considers the hazards of space flight under three main sections, dealing respectively with the ecology of space, the biodynamics of space flight, and the ecology of the space cabin. An historical survey opens the book, and a speculative chapter on interplanetary and interstellar travel serves as an epilogue. Each of the three sections, after a general review, sets out to describe the factors concerned, using a pattern generally adopted in textbooks of more conventional medicine. Whenever possible, each factor is regarded as a disease, and discussed under the headings of definition, aetiology, pathogenesis, clinical syndrome, treatment, and prevention. This arrangement leads to some odd results. The effects of low barometric pressure, and of oxygen deficiency, are included in the first section, and described as clinical entities, together with their treatment. The discussion of the temperature environment of space, also appearing in the first part of the book, leads to an account of hypo- and hyper-thermia, and of the requirements for thermal comfort. As a result, the section on the ecology of the space cabin is somewhat starved of material, and includes only metabolism, toxicology, and psychology. The supply and storage of oxygen, required for the treatment of hypoxia, is described under the first of these headings, and so, irrationally, is oxygen toxicity.

Dr. Slager is a pathologist with an interest in radiobiology, and it is perhaps natural that she should devote two long chapters to radiation hazards. In her anxiety to be comprehensive, however, she has overstepped the boundaries of her subject; the role of visible light in the production of such rare conditions as porphyria and pellagra has no place in a book of this kind. The omissions are even more surprising than the inclusions. The only truly clinical aspect of space medicine--the monitoring of the physical condition of the astronaut during flight--is not mentioned at all, while pressure suits are dismissed in a short paragraph. Disorientation and illusions of motion, which are discussed under the heading of weightlessness, receive scant attention, and it is clear that the author has no firm understanding of angular accelerations or of Coriolis forces. In an earlier section, her selection of 50,000 feet as a functional limit of oxygenation would be regarded by most authorities as artificial. Elaboration of the unimportant, and perfunctory treatment of the essential area, in fact, the major failings of the book.

It is difficult to know at whom this expensive volume is directed. Footnotes are provided to explain such terms as "pathogenesis" and "alveoli," yet the general reader is left to swallow "ischemic necrosis" and "pneumomediastinum" unaided. The illustrations, all of which are reprinted from other works, are few in number, and show a similar mixture of the technical and the naive. Artist impressions of Dyna-Soar and a space-station keep company with the dissociation curve of oxyhaemoglobin and the distribution of the solar energy flux.

It seems a pity that this volume was published before the results of actual space flights were readily available. The inclusion of some of the practical problems of space medicine, and the omission of many of the academic issues, would have made it a far better book. (Source: Discovery, March 1963)

Tomonaga, Sin-Itiro, Quantum Mechanics. Published by North-Holland, Amsterdam; Interscience (Wiley), New York, 1962. Price $12.50. Translated from Japanese by Koshiba. Reviewed by George E. Uhlenbeck.

It has always been my opinion that the only way to teach physics at the graduate level is by combining a quasi-historical approach with the usual quasi-deductive method. This is especially true in quantum theory, for quantum theory is far from a closed subject and can therefore be appreciated and learned only by following its historical development. Although this is often recognized, it is rarely practiced. In most textbooks the student is led as quickly as possible to the technical mathematical aspects of the theory, since these are easy to teach, and therefore, supposedly easy to absorb! It is a pleasure to see that Tomonaga does not follow this example.

In this first volume of a projected three-volume treatise, which is translated from the Japanese, Tomonaga, with great skill and taste, presents the development of the quantum theory from the basic papers of Planck and Einstein through Rutherford's discovery of the atomic nucleus and Bohr's theory of atomic structure to Bohr's correspondence principle and the discovery of the matrix mechanics by Heisenberg. Of course the treatment is quasi-historical. The author says in the preface that he did not intend to write a book on the history of science and that he has arbitrarily rearranged the material to elucidate as clearly as possible the thinking of many geniuses. Of course, not everyone will agree in detail with Tomonaga's arrangement. I would have given more emphasis to the interference experiments and the superposition principle, and I would not have omitted Einstein's 1917 paper on radiation theory. But one must say that in general, the author has been remarkably successful in capturing the real spirit of the development of the quantum theory. I admire especially chapter 5, on the birth of matrix mechanics.

The writing is very clear, and the mathematical apparatus is kept at the irreducible minimum. The book is also self-contained so that it can be used as a text book. In the second volume the author intends to treat, in the same manner, the development of wave mechanics, and the third volume will conclude with a systematic and deductive presentation of the whole theory. If the author fulfills the promise of this first volume, we will finally have a treatise that can be recommended without reservation to the serious student for self study or which could be used admirably in a three-semester course in quantum mechanics. (Source: Science, May 24, 1963)

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