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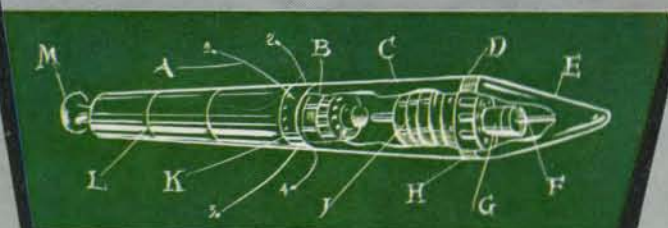

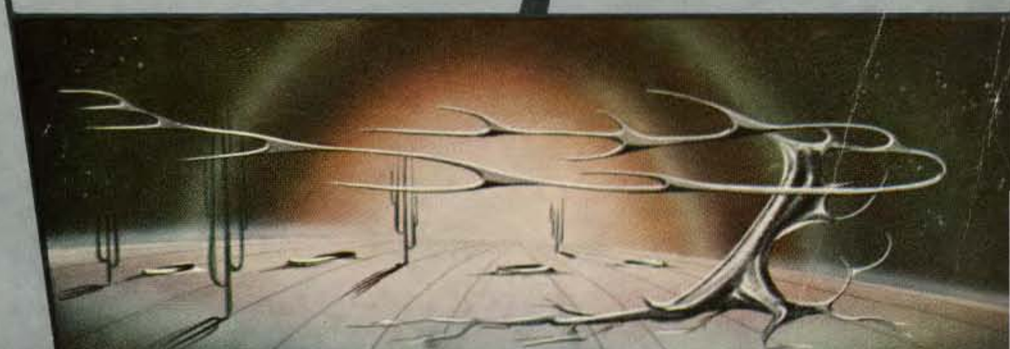

- LIFE ON OTHER STARS
  Dr. Ernst Stuhlinger
- THE EXPLORER SATELLITES
  Dr. Charles Lundquist
- PURPOSE OF MAN IN THE UNIVERSE
  John Hulley

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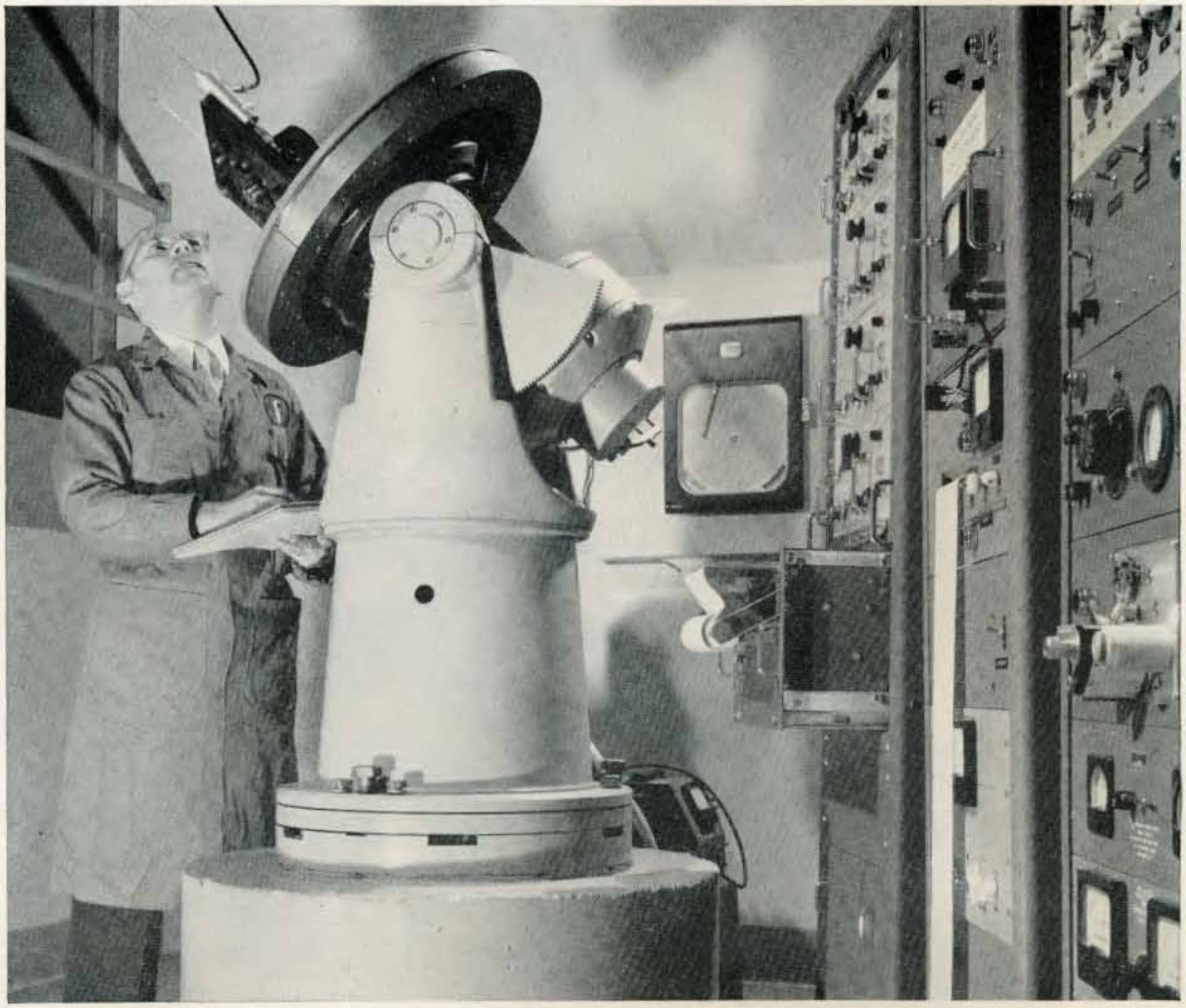

SPACE JOURNAL OF THE ASTRO-SCIENCES

CONTENTS

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SUBMISSION OF MATERIAL

The submission of material to this Journal is always welcome; short articles of 500 to 3000 words are preferred. Send the original on white bond paper, typewritten, double spaced; plus two carbons. Leave at least a one-inch margin on all sides and key all illustrations with the text. Photographs should be 8 x 10 inches on glossy stock. The author's name and title should be on the manuscript. A picture of the author and a short biographical note are required for publication. Security clearance for all material submitted is the responsibility of the author. Please send material to SPACE Journal P. O. Box 82, Huntsville, Alabama. All material accepted for publication becomes the exclusive property of SPACE Journal.

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Projecting With Space Journal

By James L. Daniels, Jr.
associate editor

Recently I had lunch with a Sunday supplement magazine editor who is interested in our magazine venture in the space field. This editor, a veteran of nearly three decades in the publishing business, asked a question which has come to us in various forms from readers, advertisers, and publishers: "What has SPACE Journal to offer that any other magazine hasn't?" Then, of course, he asked the logical subsequent questions about direction and objectives.

The answer to the basic question is simple: SPACE Journal offers the layman the best thinking of the leading authorities in the astro-sciences and in Space Age philosophy in language that he, the layman, can understand. The layman cannot get such authentic and informative material elsewhere for two reasons: one, these authors do not normally appear in other popular magazines; two, when their work is published it is usually in technical and scientific publications and in complex technical language which the layman cannot understand.

From this answer the logical extension of the first question arises: "Why?" The answer to this one falls in the category of objectives and direction. The "why" we wish to offer the layman space information becomes the "what" of our objective and the "where" and "which" of our direction.

Our objective is the motivation of man to survive. We believe that the human race can continue to develop and to survive only through moving out into the vast reaches of this ever-expanding universe. We want no ordered, stagnant, communal existence and slow intellectual death under government-regulated birth, life, and death, no *Brave New World*—restrictions which necessarily will be imposed if man remains rooted to *terra firma*. As Malthus knew, the Earth has its limits in numbers of animals it can support. Already scientists are predicting that within a few years the elimination of most animal life other than human will be a necessity. Even with scientific and technological efficiency that may surpass all known bounds, man, if he remains on Earth, will ultimately have to curb his indiscriminate spawning and cramp himself into far less space per person than he now has, even in his postage stamp urban lots and tenement hovels. He will be forced to sacrifice his individual existence to the supreme organism, the state, so that, once achieved, the metabolic balance of the whole can be maintained. Finally, if man does achieve this precarious balance for physical survival on Earth, he must eventually perish with his own solar system when its life giving sun at last goes out.

Therefore, we must get out. Our earthbound frontiers are gone; we must explore the new ones; we must open the universe for man's incessant migration so that he may continue to grow, to expand his power to comprehend, and to progress up the infinite ladder of time.

Holding these views, SPACE Journal has no difficulty in choosing its direction. The route through space is via the mind of the layman. For it is the layman who will "foot" the bill for space exploration. It is the layman whose world or worlds will be left to his progeny. Thus he is most vitally affected by every step toward space exploration, and we believe he recognizes this. And now that the science fiction ventures of a few years ago have completed the cycle from vague possibility to certainty, in the light of technological advances in the missile and satellite fields, the layman hungers to *know*—to know what he is going to pay for, to know what he is leaving to his children.

We of SPACE Journal want him to know. We want him to pay for and pass on to his progeny the opportunity and the challenge to survive—to insure the perpetuity of human kind in this grand cosmos. And we believe that the more he knows the more he will be motivated to do just that—the more he will be willing to assume his obligation to his own species.

the purpose of man in the universse

By John Hulley

John Hulley was born in Florida and educated in Europe and the United States, graduating *magna cum laude* from Harvard in 1944. A veteran of World War II, he has worked for the Office of Strategic Services as a historian and was chief of the European Regional Staff in the Washington headquarters of the Marshall Plan. At present he lives in Washington, D. C. where he is doing original research into space philosophy from the ecological approach.

In his series of BBC talks, published as *The Nature of the Universe* (Blackwell, 1950), astronomer Fred Hoyle concluded with a question and a surmise. "What is man's place?" he asked. Are we "ingenious machines," having no significant connection with the cosmos? Or is the Bible right in placing man at the center of the universe, the primary object of a personal God's solicitude? Dissatisfied with available conclusions, he offered an opinion both humble and hopeful:

> When by patient inquiry we learn the answer to any problem we always find, both as a whole and in detail, that the answer thus revealed is finer in concept and design than anything we could ever have arrived at by a random guess. (p. 118)

Within their field, ecologists would probably concur. Each natural species—animal or plant—seems so perfectly made for its specific task that one is led to expect to find a similar perfection in the human organism.

Ecology studies the way the various species interact in the natural scheme. One of the most familiar examples of this interaction is the bee which, in its quest for nectar, transfers fertilizing pollen from flower to flower. A similar coordination of work appears among all the species. Plant seeds pass intact through animal digestive systems, thus achieving wide dissemination and good opportunity for growth. The effect of the worm's digestive activity is to fertilize the soil; the digestive habits of one species of woodpecker serves to preserve certain trees from destruction by excessive beetle populations, and so on. Under close scrutiny, nature's interaction appears as cooperative as it is competitive.

Individuals of each species, seeking their own fulfillment, actually play a creative part in a much larger pattern. Photosynthetically, plants convert solar rays into food which the insects, reptiles, and animals of ocean, forest, and plain gradually pyramid into what ecologists call the "climax culture."

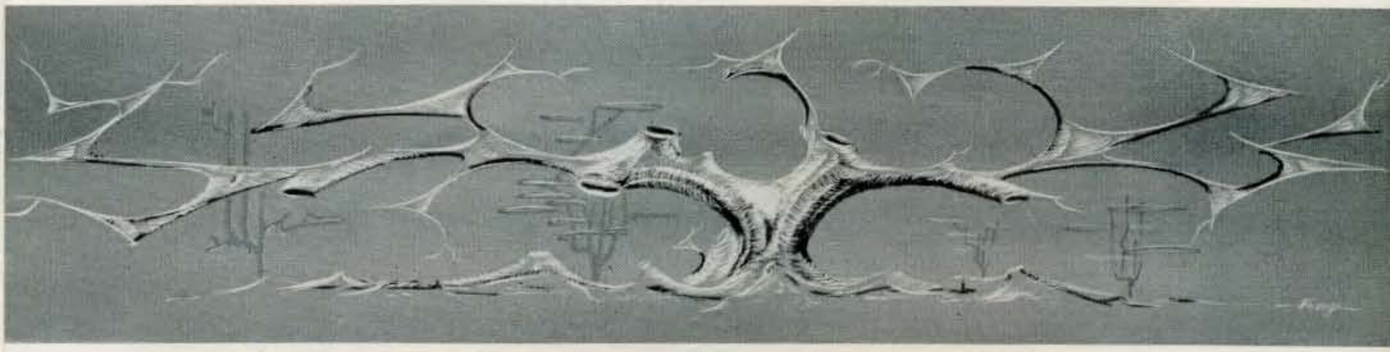
A growing respect for nature derives from this 60-year old science. For instance, the natural balance of species in any locality appears to be a richer and more efficient utilizer of solar energy than man brings about artificially. This discovery has led to the development of so-called "organic" farming, the compost heap, and many other changes in conservation, fishing and agricultural programs.

All these conclusions apply, then, to the other species. But the human role is not so clear.

The ecology of man has yet to be explained. Within the natural balance on Earth, he seems not to fit at all:

> Natural communities are characterized by a positive or favorable energy budget. Many, perhaps most, areas controlled by man are exploited, resulting in a negative energy budget, the final mark of which is unproductiveness and abandonment. (*Encyclopedia Britannica*, 1954; "Plant Ecology")

The fire, clearing, drainage, agriculture, city-building, smoke, etc. of human activity in terrestrial history seems to work counter to all



the delicate energy-exchange of nature. Man has powers which permit him to overwhelm, exterminate, or exploit all other species. Organic farming and conservation programs barely mitigate his tendencies to crush all before him.

Throughout his history on Earth, man has appeared anomalous. Far overbalancing the other species on the planet, his role has seemed more destructive than anything else. Calling upon the stars and the heavens for salvation, he has worked, fought, suffered and died—often carrying to his grave the deepest doubts about the purpose and value of his existence. Whereas all other elements of the natural order seem to find their places and to fulfill their roles in calm acceptance, human beings exhibit confusion. Why this anxiety, this storm and stress? What is man's place in the universe anyway? Analyzing his activity within the frame of nature on Earth has so far yielded no satisfactory ecological explanation.

Recent events have opened up the idea of an entirely new answer to the ancient riddle. As outer space becomes a felt reality, as interplanetary exploration becomes a scientific possibility, a new hypothesis about man presents itself.

Nature surely extends far beyond any one planet. Earth spins within a universe, whose myriad stars almost certainly have evolved countless planetary systems teeming with life. Man's place in the natural scheme, then, may be one which extends beyond the limits of a single planet.

Since Galileo, the idea of a living, populated universe has been familiar. That is the outlook of leading astronomers today—e.g., Jones and Hoyle of Great Britain, Shapley and Struve of the United States. At least two of these men further believe that biochemical laws favor a similar evolution on other planets. No one specifies the color or size, but the stated probability is that—if we keep going out into space—this, or a later, generation will encounter beings resembling us.

If human beings are indeed a normal planetary development throughout the universe, a theory of man should extend beyond the confines of any one planet and become broadly applicable. While our scientific observations are mostly limited to this single world, nevertheless our theoretical framework should approach man as a commonplace organism frequently occurring and active in the larger natural scheme.

Within the acknowledged limitation of our experience, a philosophical approach to the problem can yet be made from available scientific sources. The allied disciplines of evolutionary biology and of ecology offer the basis.

Certain characteristics distinguish man from other species, but they do not necessarily set him apart from nature itself. As a mammal, man converts specific forms of energy into other forms. Within his own body he ingests and processes certain fruits, nuts, leaves, roots, flesh and bones into sound, heat and action. His defecation and finally his dead body nourish plants. Thus he forms an integral link in the natural energy chain.

His differences may simply fit him for an interplanetary role within the cosmic natural pattern. The same four limbs which in other mammals are designed either for quadrupedal walking or tree-climbing, seem particularly designed on human beings for another purpose: erect posture frees the hands for the manipulation of tools, whether rudimentary or ultramodern. Erect posture also raises the vision and makes it easier to focus upward and outward.

An instinctive interest seems to lead man to a close scrutiny of the heavens. For him astronomy is the "queen of sciences" and, for millennia, the only one. In the early periods of his progress he builds myths or religions about the celestial bodies, worshipping the

Sun and Moon, Jupiter, Venus and Mars, or Quetzalcoatl, or Odin. He locates his future salvation in an unearthly or other-worldly life in Heaven. He links his military adventures with celestial portents and his amorous desires to the Moon or to Star-dust. In all times and places, his history reveals a troubled consciousness of the great universe around him.

This celestial focus differentiates him and narrows his range of receptivity. If other animals are not far-sighted enough to see the stars, and almost certainly ignore them, they make up for it by perceiving things which man fails to note. A dog hears sounds which the human ear misses. The owl strikes at its midget prey when human beings are lost in the dark. Nearly all animals follow telltale scents too refined for human perception. Bats and fish respond to vibrations which man cannot feel; and so on. Human perception of the celestial environment and relative insensitivity to earthly sounds, smells, and vibrations apparently constitute an innate specialization within the natural scheme.

From the invention of the lever and the wheel down to the launching of artificial earth satellites, man has revealed a distinctive ability to carry out increasingly complex operations. This ability depends upon his elaborate communication system. Many species (e.g. birds) use systems of signals sounds, movements, vibrations—to coordinate group activities. The human system of symbols is much more elaborate. One of the most articulate of our species on Earth, Shakespeare, is calculated to have used over 25,000 different words; and, of course, an individual understands more words than he uses.

Through words, man communicates a partial reproduction of certain processes, both natural and artificial. If he is just one of the natural species having a particular ecological function, limitations on his faculties are to be expected. For instance, he can describe the growth and decline of the stars and galaxies of our universe, but he cannot tell why the universe exists. His reproduction of these processes is descriptive, comparative, analogical. He knows how to make an atom explode, but he does not know why an atom or an explosion is. Even within the descriptive realm his capacity to reproduce reality in words reaches limits beyond which he cannot go. How big or how old is the universe? Such a question leads beyond man's needs for practical activity. Here his symbols fail. On the one hand, he cannot conceive that the universe stops in a certain place, because something would have to be beyond; on the other hand, he uses the word infinity, but cannot really imagine it. He has equal difficulty in conceiving either that the universe had a beginning or that it did not.

Man is not omniscient, nor capable of being omniscient. His mental equipment is not designed to enable him to comprehend all the mysteries and ultimate meanings. However, it is well designed to enable him to operate at a certain level within the universe. He can learn the motions of the stars and planets, the gravitic, electromagnetic and other fields of outer space, the principles and mechanics of flight. For this sort of purpose, indeed, his equipment seems perfect.

Instinctively, sentient human beings have long been drawn to the idea of flight. For centuries men have actually dreamed of flying. Lindbergh's crossing of the Atlantic Ocean drew forth a greater popular response than the victories of military heroes. From boyhood on, men find special thrills in speed, in operating complex machinery, in sitting behind the controlboard of fast-moving vehicles, in exploring the unknown. Within the limitations of Earthly life, men put "rocket" engines in their cars, mount high stabilizer fins on the rear fenders, and seek rides which will take them "out of this world." They read Buck Rogers and other space or science fiction. Such dreaming, reading, and play-acting seem wholly natural if the make-believe of today prepares for the reality of tomorrow.

Ecological analysis suggests that each species, pursuing its own ends, not only promotes its own survival but actually plays a useful role in the build-up of a rich, natural pattern of energy-exchange. Why space flight is important to human ends will be discussed in a later article. The ecological

question here under discussion is: How does that activity contribute to the natural balance? To this question, analogy suggests that fertilization may be the answer.

Within the limits of a single planet, birds, bees and many other animals disseminate the seeds and pollen of the plants. In the exploration of planets, many of them either completely rocky and dusty or else supporting only rudimentary forms of life, men would naturally seek those planets which could support advanced life-forms. To these he would bring plants and animals to support human cultures. Presumably he would bring some back, too. He would thus actually enrich natural activity in the area of his explorations. Like an interplanetary bird or bee, his disseminating agency would contribute to the profusion of life on the planets he reaches.

He may do more. Long-period comets and polar shifts may become subject to his forecasting. Ultimately he may seek to exert his influence to prepare for, mitigate, or perhaps even offset any major impact. Such activities are familiar to him in his Earthly history of developing new lands and continents. An ancestral foreshadowing of the activity is contained in two of the most memorable biblical accounts: the variant stories of the creation and fertilization of the Earth (Genesis 1 and 2); and the story of the preservation of species in Noah's ark (Genesis 7). His future activities in the universe may resemble those ancient tales.

The hypothesis developed in the preceding sections would also explain the struggles and strains of history. The main problems of successive generations would be to develop the required ability, based on the amassing of observations and formulation of words/ideas. The flexing of scientific muscles in war, the groping for purpose and meaningful relationship to the cosmos—through religion, philosophy and poetry—would all contribute to the growth of the species toward its mature role in the universe.

Such an incubation period may seem slow to a human individual. But the natural universe allows for long time-spans. The ages of stars and planets are numbered in billions of years. The growth of a rich natural balance in a swamp may require millions of generations of insects. Ecologic progression may depend upon thousands of generations of one type of anthropoid displacing thousands of generations of another.

It takes a caterpillar only a few weeks to develop into a butterfly. But the activities of the butterfly are relatively simple. It seems well within the time-spans of the natural scheme if humans require a few hundred generations to evolve within their collective cocoon or incubation-planet, before achieving the elaborate operation of interplanetary flight.

If these comparisons are valid, then the present historical moment is a vital stage of social transition from a quasi-larval condition to that of full flight. Successful accomplishment of the transition will partly depend on our true understanding of its character and purpose. To that end, this article has been devoted to an interpretation of the function of human interplanetary flight from the point of nature as a whole. A later article will review the usefulness of space flight directly to humans, evaluating its importance for our growth and ultimate survival.

launching the explorer satellites

By James L. Stamy

James L. Stamy was born in Cedar Rapids, Iowa, on August 13, 1918. He attended Webster City Junior College and obtained his B.S. in Mechanical Engineering from Iowa State College in 1946. He has been working in the field of ground support equipment development since 1950 at the Army Ballistic Missile Agency at Redstone Arsenal.

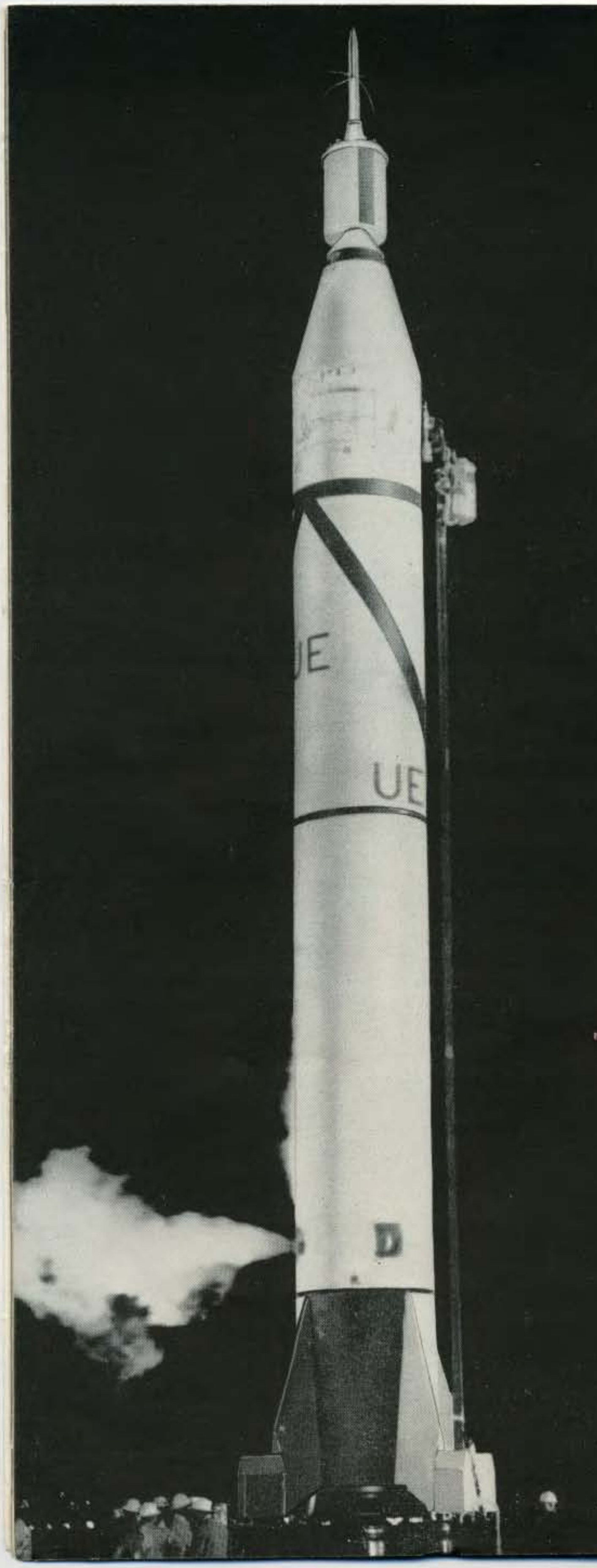
On November 8, 1957, the Secretary of Defense announced that the U.S. Army was to participate in the scientific program of the International Geophysical Year. It is now a matter of history that 83 days later at 4.8 seconds after 10:55 P.M. (EST) on January 31, 1958, Explorer I was placed in orbit, and in 114.8 minutes it had completed its first journey around Earth.

Many readers, both students and practicing engineers, are familiar with the length of time that elapses between the initiation of a design and the realization of the operating hardware. It is obvious that a task of the magnitude required for the launching of an Earth satellite cannot be carried out within an 83-day period without utilizing a great deal of existing hardware, and this has been true in the Explorer program.

For a number of years the Army Ballistic Missile Agency has been developing the Redstone, a medium range, surface to surface, ballistic missile. When the intermediate range ballistic missile, Jupiter, was assigned to the Agency, it was recognized that the development program could be compressed if certain critical components and subsystems could be flight-tested during the time that design and production of the basic Jupiter missile were being accomplished. The existing Redstone missile proved to be a valuable test vehicle for this purpose, and a certain number of these missiles were modified and renamed Jupiter-A. This proved to be a satisfactory solution to many of the design and development problems for Jupiter components; however, there was one outstanding problem which required advanced testing techniques, and this was the famous re-entry problem. The major task, in this case, was the protection of the Jupiter warhead from the terrific heat generated by friction as it re-enters, at hypersonic velocities, the atmosphere from essentially outer space conditions.

In order to obtain vital test data under actual conditions with existing hardware, it was necessary to "soup up" the basic Redstone design. This called for the use of a higher energy fuel than normally is required. This fuel, unsymmetrical dimethylhydrazine, afforded the necessary increase in the thrust level for the engine. In addition, the burning time of this basic Redstone thrust unit forming the first stage of this composite missile was increased by lengthening the propellant tanks. This could be done since the weight of the upper stages was less than that of the Redstone top unit which it replaced. Even these measures were insufficient to give the overall performance required, and so additional propulsion stages were needed. These were designed, developed, and tested by the Jet Propulsion Laboratory of the California Institute of Technology. At this time they were working on a variety of solid-propellant missiles for the Army Ordnance Corps and were confident that, with some modifications, they had rocket motors suitable for the task and that they

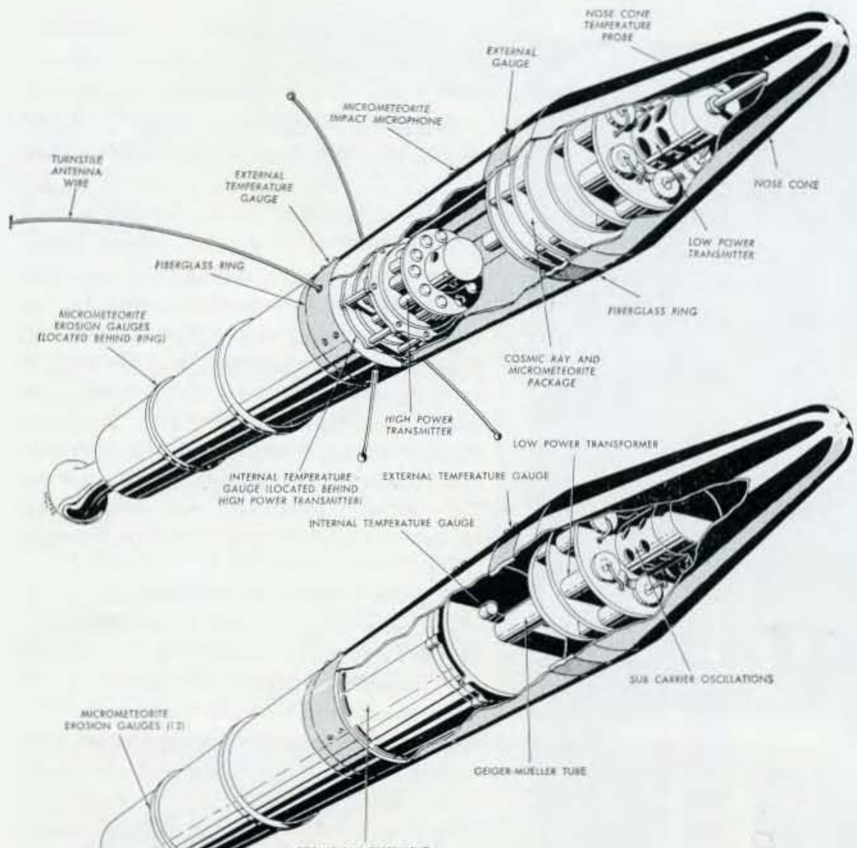
The service structure containing the Jupiter-C missile as it nears firing at Cape Canaveral, Fla. Seconds before the missile is fired and after all tests and fueling are complete, the structure is rolled away from the missile. ▶



could design and produce the system for firing these motors from the forward end of the Redstone thrust unit. The resulting missile was the Jupiter-C. In August, 1957, one of these missiles was fired, and it was one of these nose cones which President Eisenhower displayed in a television address last November when he announced that the United States had solved the re-entry heating problem.

Thus the Jupiter-C became an available vehicle, which, for orbital missions, required one additional propulsion stage along with the instrumented satellite itself. On the basis of studies which had already been performed, the Jet Propulsion Laboratory was given the task of constructing and instrumenting the actual satellite to be placed into orbit and the coordination of the proposed scientific program with IGY personnel. The payload section of Explorer I contains several types of instrumentation for making environmental measurements in the thin reaches of outer space. Miniaturized radio transmitters, using the newly-developed microlock radio techniques, were employed for telemetering back to Earth the scientific information the satellite gathered. Two totally independent radios were installed in the vehicle and transmitted information on internal, skin, and nose cone temperatures; micrometeorite impact; and cosmic ray counts.

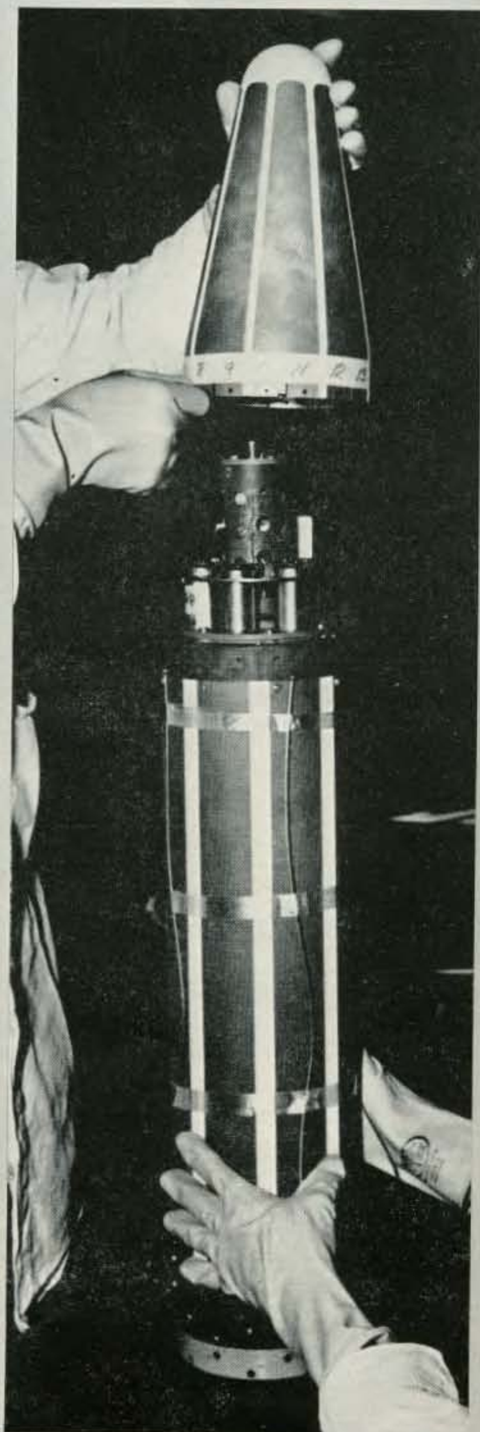
The U.S. Army's Jupiter-C missile stands poised for flight with the earth satellite Explorer I. The satellite's four antennas can be clearly seen.



Cutaway views of Explorers I and III. Both satellites measure cosmic radiation intensity, density of meteorite particles, and temperatures inside and outside the satellite.

The low power transmitter operated on a frequency of 108 megacycles, and the high power transmitter operated on a frequency of 108.03 megacycles. The low power transmitter was expected to transmit data for two to three months before its batteries discharged; the high power transmitter, on the other hand, was expected to last only two weeks. These expectations have been fulfilled.

The analytical problem of determining how the outer surface of the satellite should be prepared in order to obtain proper temperature control of the interior is a very difficult one. The vehicle is exposed to the full radiation of the Sun; and, in turn, it becomes a radiating body as it passes into Earth's shadow. The temperature assumed by the interior mechanisms depends on this radiation balance and the heat conduction path between the electronic components and the exterior environment. In view of this, it is desirable to measure the temperature at several points inside and outside the satellite, and this information is of vital importance for the proper design of future satellites.



Final assembly of the Explorer I satellite. One of the satellite's two radio transmitters is visible in the lower section.

Erosion by cosmic debris is also an important factor. The measurement of it is made in two ways: first, by means of an impact microphone mounted on the exterior surface of the satellite which registers collisions occurring anywhere on the outside of the satellite. The microphone experiment indicates the frequency of impact by particles with more than a certain minimum momentum. Second, a system of grids composed of very small wires wound on a core was installed near the aft end of the satellite to measure impacts by meteorite particles greater than a certain minimum mass. The meteorite experiment was designed by M. Dubin of the Air Force Cambridge Research Center.

A geiger counter and an associated scaling circuit were also included in the Explorer I for the purpose of measuring cosmic radiation and transmitting its intensity back to Earth. The measurements were all made continuously and transmitted simultaneously, and no type of information storage device was used. Data gathered by the satellite was picked up by ground stations during the satellite's passage over head. This cosmic ray experiment was designed by Dr. James A. Van Allen of the State University of Iowa.

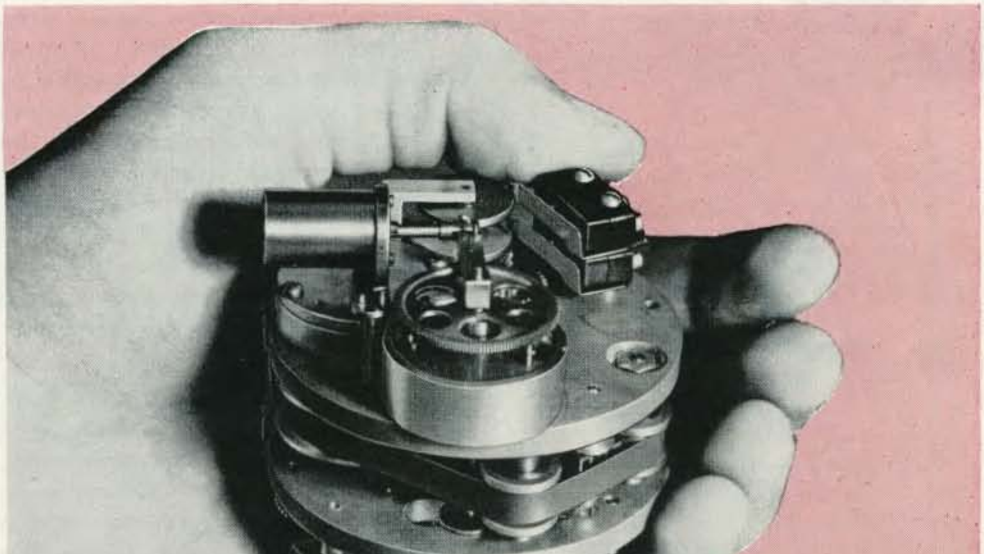
In addition to information received directly from the satellite through its instruments, it also provides basic scientific information simply by being in orbit. Ground observations of the satellite provide data about the ionosphere, Earth's magnetic field, and atmospheric density that, until now, has been based on indirect evidence and theoretical assumptions. Accurate optical and radio observation of changes in the satellite's orbit also provide basic information as to gravitational anomalies in the Earth's field. The exact amount to which Earth's shape deviates from an ideal sphere can thus be determined from such observations.

Explorer III which was subsequently launched is also in orbit at this time. This vehicle is gathering and transmitting the same type of information as Explorer I. There are essentially no differences between the carrier vehicle or the launching methods of the satellites. There are, however, several significant changes in the instrumentation of Explorer III.

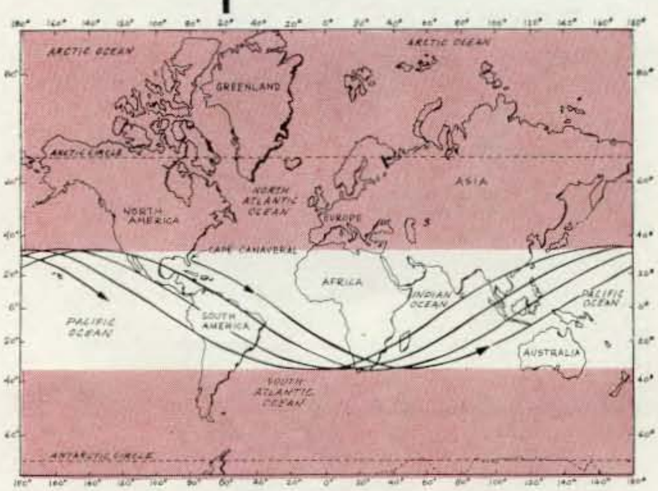
A major change in the satellite is the addition of a miniature tape recorder, developed by the State University of Iowa. This device is collecting and recording on tape the data on cosmic radiation encountered during the total orbit. This information is played back upon a signal given from a ground station. The tape is then automatically erased and reset.

Scientists consider information gained from this memory system a marked improvement over that of Explorer I. The first satellite dispatched data continuously; but it was received only in areas under the orbital band that had

The geiger counter used in both Explorers for measurement of cosmic ray intensity.

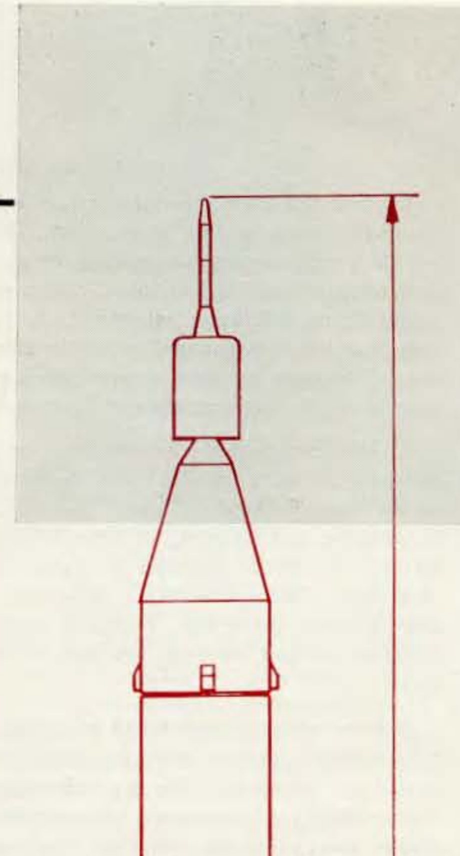


This extremely small tape recorder, in Explorer III, records data on the presence of cosmic rays during the satellite's total orbit. On a signal from the Earth, the recorder reports the information it has gathered during the orbit, automatically erases and resets itself—all in a few seconds.



The first four orbits of Explorer III over the Earth. The Jupiter-C, which launched the satellite, was fired at a 35 degree inclination to the Equator. The satellite is orbiting on an equatorial band between the 35th latitudes north and south.

ground stations. Many blanks thus occurred in Explorer I's record, particularly when the satellite was over large bodies of water. Explorer III, however, is sending out cosmic radiation information representative of the total orbit. Thus, there is being conducted, for the first time, a comprehensive survey of total cosmic ray intensity above Earth with respect to both time and position.



The prelaunching procedure for both Explorers was much like the standard operation for any large, liquid-propelled missile. All of the functions of checkout, propulsion system testing, fueling, azimuth alignments, telemetering checkout etc. were carried out. During the latter stages of the ascent, the main power plant was expended. It separated, and fell back to Earth. The upper stages shortly afterward reached the apex of the arc. Just prior to the time when the vehicle attained its maximum height, the second stage was fired.

The first stage of the missile carried the payload to its perigee distance from the Earth. Other stages of the missile increased the satellite's speed to that necessary for orbiting, a minimum of 18,000 miles per hour. The upper stages were spin-stabilized, in much the manner of a rifle bullet. This was done by electric motors mounted within the nose section of the main stage.

The upper stages were solid propellant systems. The final stage motor and the satellite were not separated. They are orbiting together. They have a total length of approximately 80 inches and weigh 31.0 pounds.

spatial orientation of the explorer satellites

By Charles Lundquist

Charles A. Lundquist was born in Webster, South Dakota. He received his bachelor's degree in engineering physics from South Dakota State College in 1949 and his doctorate from the University of Kansas. He was an assistant professor of engineering research at Pennsylvania State University during the period 1953-54. After entering the Army he was stationed at Redstone Arsenal from 1954 to 1956. Upon his discharge he assumed the duties of his present position which is Chief, Physics and Astrophysics Section, Research Projects Office in the Army Ballistic Missile Agency. He is married and has two daughters.

The launchings of the first United States satellites have received widespread notice. But less well known is the analysis required as the bodies continue to orbit. The complete reduction of scientific information from the satellites is a long and laborious process, and final conclusions can be reached only many months after launching.

One of the many interesting questions to be considered is the satellite orientation or attitude in space. This consideration has many implications. Changes in the time for a revolution about the Earth—the period, the strength of radio signals received from the satellite, the brightness of the body compared to the stars, and the temperatures in the satellite are all affected by the satellite's orientation in space.

When a bullet leaves the muzzle of a rifle, it is spinning rapidly. In its flight to the target, this spin keeps the nose of the bullet pointing forward. The original orientation with which the spinning bullet began its flight is maintained by the gyroscopic principle. Thus, the bullet's attitude or position relative to the Earth, is fixed in space by the orientation of its axis and the spinning motion imparted to it. The same principle is used in launching the Explorer satellites. The last three stages of the Jupiter-C and the instrumentation packages are spinning from the time the rocket leaves the ground. For this reason the satellites enter their orbits under much the same conditions as a bullet beginning its flight.

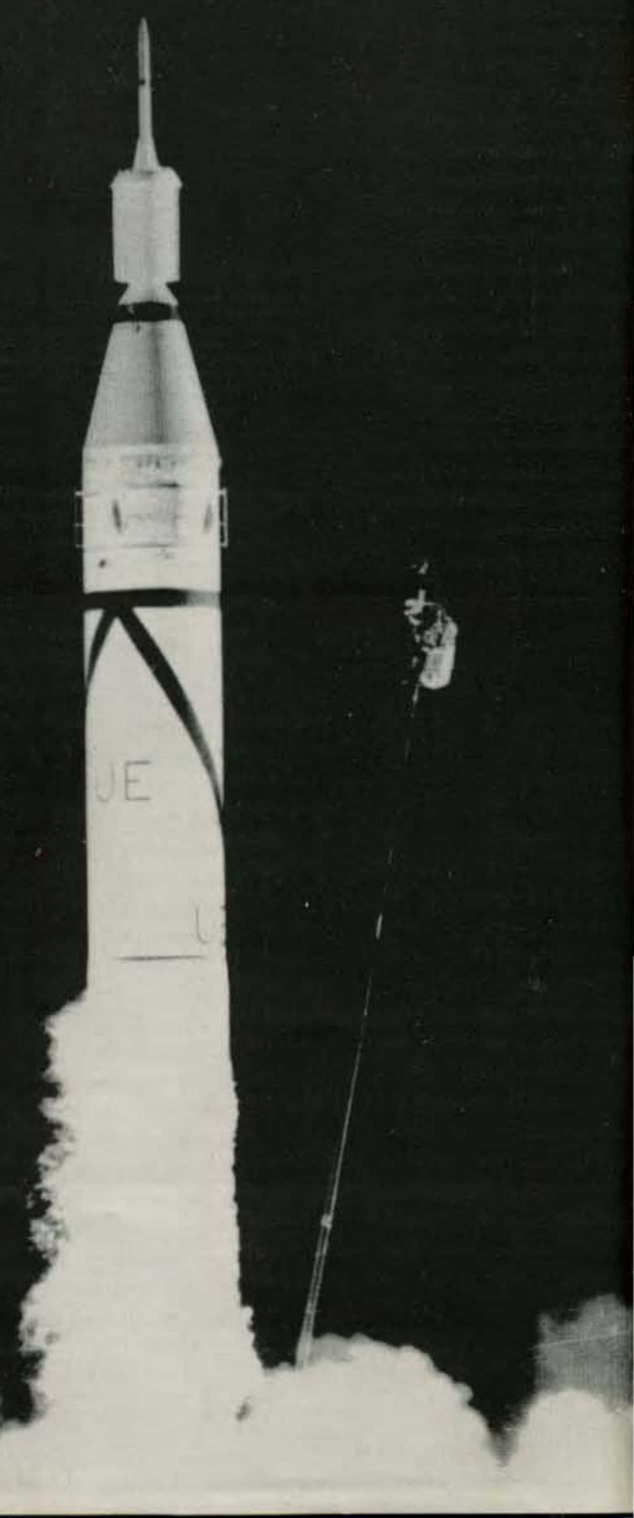
If these satellites were perfectly rigid bodies and if they were not acted upon by external forces, the laws of mechanics demand that the orientation of the axis of spin of the satellite remain forever fixed in space. (See fig. 1.) By these same laws, the polar axis of the Earth is required to always point to the North Star as the Earth revolves in its orbit.

The Explorer bodies are, however, acted upon by external forces. Further, Explorer I is not a rigid body because the four antennas for one of its radio transmitters are made of flexible cable. (See fig. 2.) Thus, the attitude of these satellites will not be fixed in space. For this reason the situation is somewhat more complicated and interesting.

Even at the normal height of present satellites, enough atmosphere remains to retard their motion. This resistance is proportional to the amount of satellite surface area projected in the direction of its flight. Thus, the Explorers intercept 16 times more of these particles if they move broadside than if they move end on. (See fig. 3.) The corresponding atmospheric drag on the satellite body affects the shape of its orbit and these orbital changes may be observed. Then, if the orientation of the satellite, its shape, velocity, and position are known, the atmospheric density may be deduced from observed orbital changes.

Significant data from the satellites has been gained by studying the strength of their radio signals at various times relative to the orientation of the bodies. The radio transmitters on a satellite do not radiate with the same strength in all directions. Due to the arrangement of the antennas about the body, a stronger signal is transmitted in one direction than in another. Likewise, the signal strength picked up by a receiver on the Earth depends upon the satellite orientation and spin and upon the electron density in the ionosphere between the receiver and the transmitter, due to the reflection or interference with the signals. Again, if the satellite orientation is known, then the two conditions can be separated and useful information can be determined regarding the height and density of the ionized gas layers between the satellite and the Earth.

The temperature data gathered must also be considered in terms of satellite orientation. The temperatures at various points on the satellites depends upon two competing processes. Radiant energy from the Sun and the Earth is absorbed, making temperatures higher. On the other hand, the body itself radiates heat in accordance with Planck's Law. A balance between these two processes determines the satellite's temperatures. The amount of radiant solar energy which a satellite absorbs is proportional to its area illuminated by the Sun. It will be much warmer if a whole side is subjected to solar radiation than if only one end is radiated. The same is true for the radiation from the Earth. Therefore, orientation is of great importance in determining internal and skin temperatures of the satellite.



Launching of the Jupiter-C missile wtih the satellite Explorer I at 10:48 PM, EST, 31 January 1958.

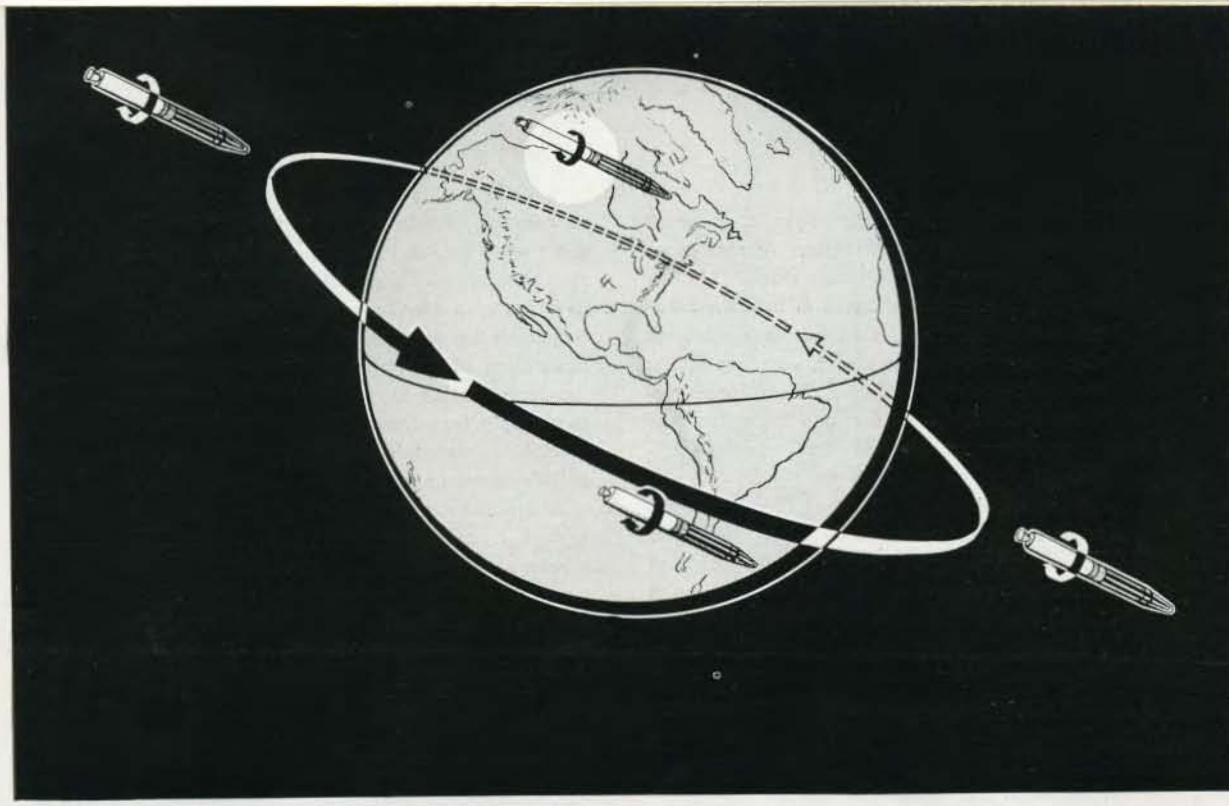


Figure 1. Attitude which Explorer I would have assumed under ideal conditions.

Another important factor interrelated with orientation is the satellite's relative brightness as viewed from the Earth. This apparent brightness, as compared to background stars, primarily depends upon how the body is aligned with respect to the Sun and the observer. Thus during dawn and dusk observation conditions the satellite's alignment in space will determine the reflecting surface visible to observers. Of course, the reflectivity of the satellite also effects its apparent brightness. Studies have been conducted to judge the effect of various satellite positions and alignments on the exposed reflecting surface and the subsequent satellite brightness at various altitudes. The assumed orientation and spinning motion could be verified by accurate

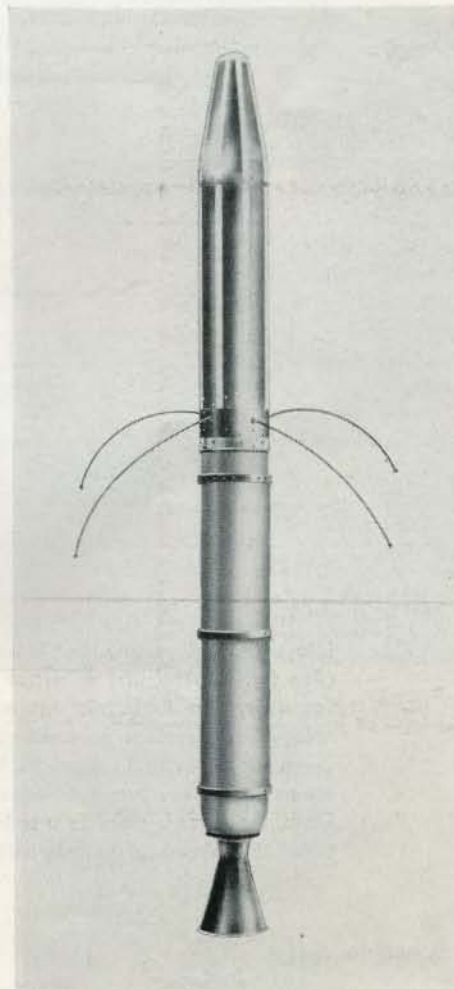


Figure 2. The Explorer I satellite which consists of the instrumentation package plus the fourth stage.

observations which note changes in apparent brightness. The Smithsonian Astrophysical Observatory is analysing such data.

Finally, orientation again is important because torques are exerted on these satellites since they act as conductors, spinning in the magnetic field of the Earth. These forces depend upon the direction and magnitude of the Earth's magnetic field relative to the satellite.

The resistance encountered, temperatures, apparent brightness, radio signal strength, and electromagnetic torques for a spinning satellite have been seen to depend upon its alignment in space. If the satellite is a sphere, the first three are not primarily affected by orientation. Hence, all five factors are most interesting in the case of the Explorers. Changing the point of view, each of these effects may be used to help determine the attitude of the satellite in space.

Analysis of data from Explorer I supports the tentative conclusion that the satellite went into a flat spin soon after it was launched. (See fig. 4.) The first evidence of this was found by the California Institute of Technology, Jet Propulsion Laboratory, from measurements of the radio signals from the satellite. During the first few orbits about the Earth, the records point to a reduction of the bullet-like spin about the long axis of the body to a small fraction of the original rate. As this happened, a transition to the final flat spin took place. This transition from an axial to a flat spin may have been aggravated by flexing of the antennas which would allow the dissipation of energy with very little change (conservation) of the angular momentum due to the spin transition. Thus the final angular momentum approximately equalled the initial angular momentum.

At burnout the final rocket stage of Explorer 1 had a spin rate of approximately 750 revolutions per minute about its longitudinal axis. The respective moments of inertia about the longitudinal axis and the flat spin axis have a ratio of about 100 to 1. This is due to the distribution of satellite mass about

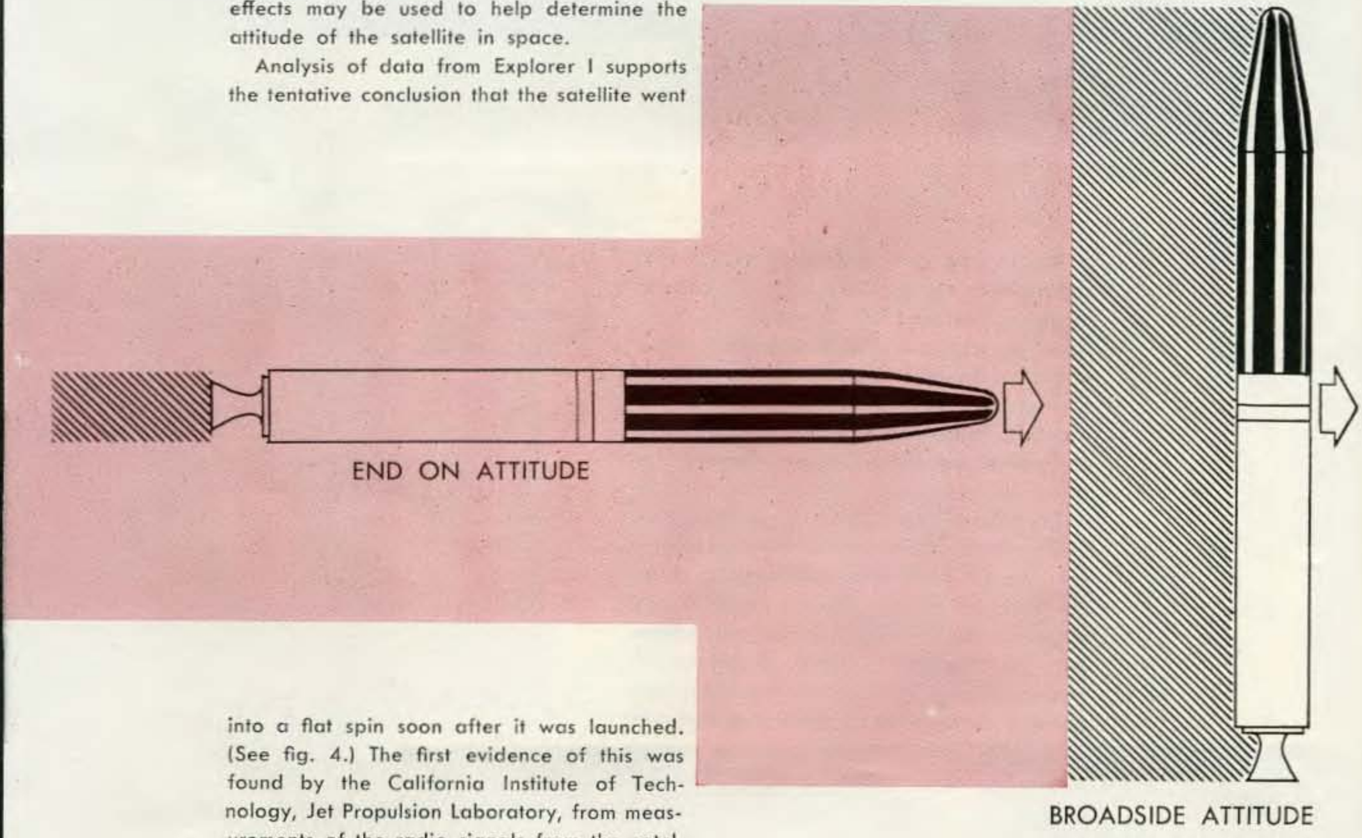


Figure 3. Drag effects on the Explorer I satellite due to the attitude of its mass. The cross-hatched areas indicate the volume swept by the satellite in either a parallel or perpendicular attitude to its orbital path.

predominant feature of later records has been a variation of radio signal strength having a period of approximately 8 seconds. A sample of such a record is shown in fig. 5. This observation is consistent with a flat spin and indicates that this is the actual condition.

Due to the oblate form of the earth, the plane and major axis of the orbit both rotate. As the Explorer I, in its flat spin, passes through the orbital perigee (closest point to the Earth) and is acted upon by appreciable drag torques, the orientation of its rotational axis will be changed. Forces of electro-

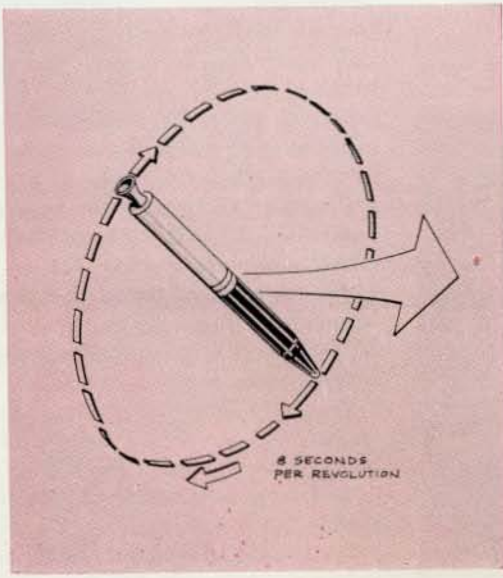


Figure 4. The flat spin of Explorer I. The spin axis is no longer parallel to the longitudinal axis. Indications are that the satellite has a period of approximately 8 seconds.

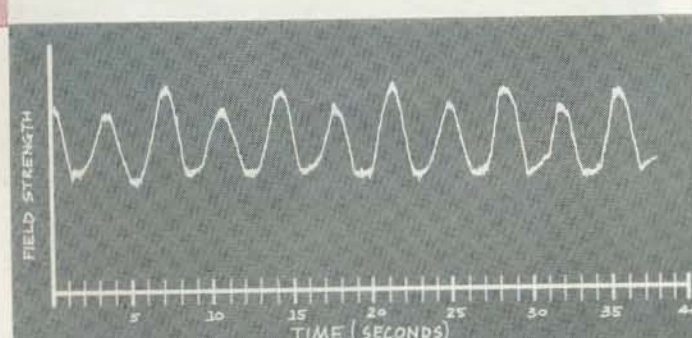


Figure 5. A typical measurement of signal strength received from Explorer I. Notice that the major peak (actual signal variation) occurs approximately every 8 seconds, indicating a flat spin rate for the satellite of the same relative time.

the different axes. If conservation of angular momentum as mentioned before is assumed, then a flat spin rate of 7.5 revolutions per minute will result due to the 100 to 1 ratio. This rate of 7.5 revolutions per minute or .125 revolution per second corresponds to a flat spin period of 8 seconds. (See fig. 4.) A magnetic origin probably cause similar deviations. Temperature data received from the satellite yields some insight into this solution.

Expected temperatures calculated under various assumptions of satellite orientation have been compared with temperature measurements made on board the satellite and telemetered to the Earth. The average interior temperature, calculated on the assumption of a flat spin and an axial spin about the long axis, are shown in an illustration. (See fig. 6.) The circled points are temperatures measured on the satellite. Note that the observational data does not agree with temperatures to be expected if the bullet-like spin remained unchanged; that is, if the transition to a flat spin did not take place. However, during the first twenty days, the predicted temperatures for the case of a flat spin whose axis is fixed in space do not agree well either. If, as previously suggested, the orientation of the axis about which the flat spin is executed, changes due to external forces, the expected temperature would have values fluctuating in the neighborhood of 300°K. This is in agreement with the observational data.

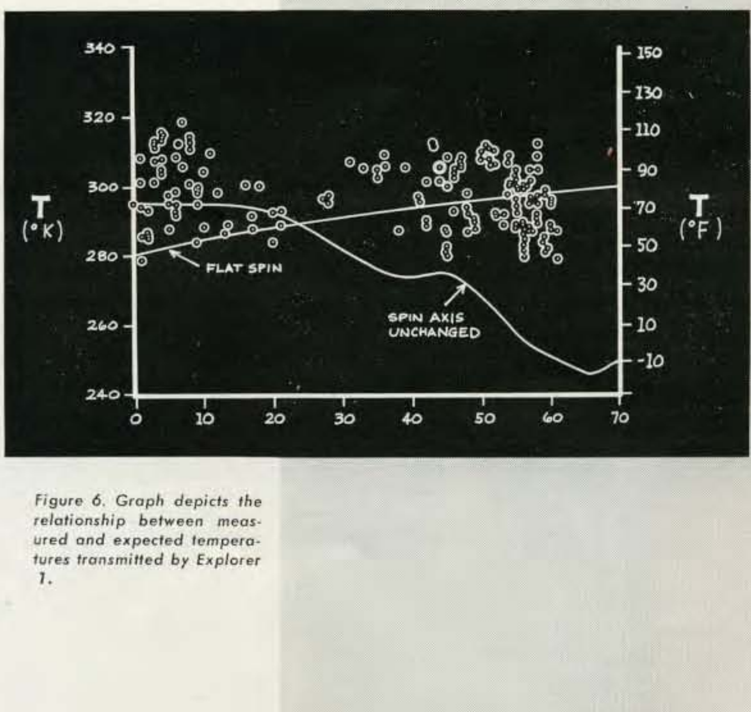


Figure 6. Graph depicts the relationship between measured and expected temperatures transmitted by Explorer I.

The Smithsonian Astrophysical Observatory has reported variation in the rate of change of the orbital period. This might also be related to the satellite attitude through proper analysis.

The flexible antennas, which probably caused the flat spin conditions on Explorer I, were omitted on Explorer III. Preliminary evidence indicates that the transition to a flat spin is much less rapid for this satellite. Thus, improvement in the satellite configuration was accomplished by analysis of available information from Explorer I records.

As this is written, the satellites in question are still orbiting and transmitting data. The analysis of the above phenomena is continuing. The final result of these studies will be an understanding of what the orientation of the satellites has been during their lives. This picture must be consistent with the observational data on the varieties discussed. Once this consistent picture is obtained, it can in turn be used with confidence in the analysis and determination of the many questions about space and space vehicles.

life on other stars

By Ernst Stuhlinger

Ernst Stuhlinger, Director of Research Projects Office, Army Ballistic Missile Agency, was born in Niederrimbach, Germany, December, 1913. He attended school at Tuebingen and received his doctorate in physics at the University of Tuebingen in 1936. He worked closely with Dr. Hans Geiger, developer of the Geiger counter, for seven years. At Peenemuende, Dr. Stuhlinger carried on research in connection with the development of guidance and control systems for the V-2 guided missile. He has gained recognition in recent years for his feasibility and design studies of electrical propulsion systems for space ships.

Part II

All the countless observations of celestial bodies, many of them with the most ingenious methods known to modern science, have not yet given us a definite proof of the existence of life in places outside of our own Earth. The only direct indication of the possibility of living matter existing on another star is the observation of green patches on the surface of Mars. These patches expand during the Martian spring and summer and recede again during fall and winter. They are commonly interpreted as being caused by green plants, probably not too different from our mosses and lichens. Other than this one observation, no trace of life has ever been observed in the universe. And yet, scientists state with a high degree of certainty that life must be expected to exist on other stars. They base this statement on a simple rule which, for a long time, has served as a most powerful and a most successful guide to the biologist. It simply states that when the necessary conditions for a certain development are fulfilled, nature initiates this development very readily. Applying this rule, we must expect that life has developed on many other celestial bodies on which the necessary conditions for its development were met at one time or another. As we assumed in the first part of this article,* there are about 100,000 planets within our galaxy which very probably are similar to Earth. That part of our universe which can be observed with today's means contains, in all likelihood, no less than ten thousand billion planets on which, at some time, conditions were favorable for the development of life.

What, then, are these conditions? First, there must be a source to supply energy in an adequate form to the living organisms. Second, there must be a source of "building material" to provide the proper raw material for their growth. Third, there must be water. Fourth, the temperature variations must be within reasonable limits, about —20°C (—4°F) to +80°C (176°F). Fifth, there must not be an excessive amount of poisons or other agents detrimental to living matter. Once life has developed on a planet, it may well adapt itself to less stringent conditions. Many organisms on Earth live and even thrive in regions where the temperature regularly drops far below zero or where there is no water or air. However, it is not probable that living organisms could grow through the very early phases of their ontogenetic development if the temperature dropped considerably below zero for longer periods or if there were no water and air.

Yet these requirements are not enough. If we fill carbon, oxygen, nitrogen, and water in a test tube, irradiate it with sun light, provide a convenient temperature and keep poisonous material out, there will still be no development of life. A living cell, even the most primitive, contains protein. The basic elements making up protein molecules are

*"Life on other Stars," part 1, SPACE Journal, spring, 1958, p. 10.

carbon, hydrogen, oxygen, and nitrogen; but each protein molecule has a very large number of atoms. These atoms are arranged in extremely complicated but very orderly patterns. Even though many different patterns of atoms may be formed just by random events in a mixture of those atoms in the course of time, it is improbable that the formation of a highly complex protein molecule, just as a random event, is completely negligible, even over a time span of millions of years. A very special force is necessary to put the atoms in the right order, to arrange them in such a way that a protein molecule results. Even so, would this complicated protein molecule, immediately after its formation be alive? Would it show the characteristic features of life, the metabolism, the regulatory processes, the growth, the tendency to procreate, the development of protective measures and, most important of all an inherent trend for evolution? These features which make live matter so characteristically different from dead matter, can they be understood at all on the basis of the laws of nature as we know them from today's physics and chemistry? Or do we have to assume a creative act from far outside the boundaries of our natural sciences? There is, I believe, only one answer which we can give in honesty: we do not know. But this very question has been with mankind as long as there has been scientific thought. It will certainly remain not only the most intriguing question of all science, but also one of the most profound questions which can be asked by man.

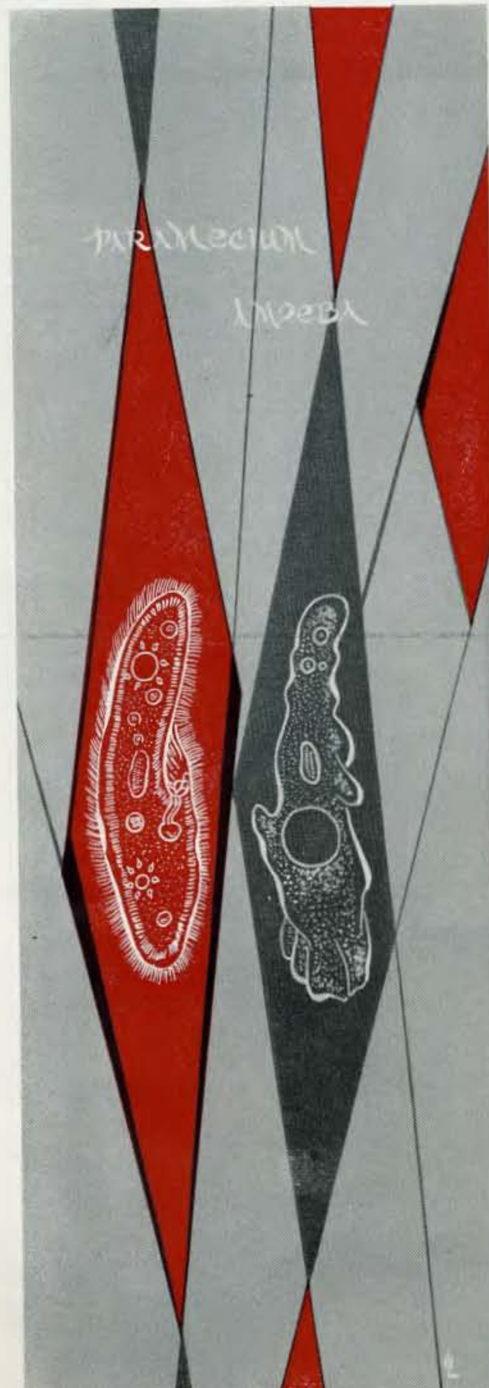
The physical sciences have given us a marvelous picture of the inorganic world, extending out to the remote galaxies of the universe and down into the submicrostructures of the atomic nuclei. We understand the laws that make the stars move; we can design complicated machines which utilize the forces and interactions of electric phenomena; we have learned to move through the air, and beyond it, with unbelievable speeds; and we draw almost limitless power from the interior of the atom. Biology has been no less successful in revealing the laws that underlie the world of animals and plants. The laws of physics and chemistry, correctly applied, are valid also in the realm of organic matter. And yet the fundamental question which faces the natural scientist is still unanswered: are the laws of physics and chemistry, including those still unknown, sufficient to explain the formation of living matter? All we can do is to continue our researches into the mysteries of nature, even if this question should remain unanswered for a very long time.

Scientists, indeed all of us, would be reluctant to assume that our little planet Earth is the only place in the vast universe on which life has developed. Although we do not know what causes a protein molecule to develop out of its basic ingredients and what makes it behave like a live protein molecule, we are confident that nature initiates this development whenever, and wherever, the conditions are right. This reasoning implies that life—even on Earth—may have started in more than one place, and more often than once. In fact, it is conceivable that molecules which possess the characteristic features of life developed many times on Earth, and continue to develop today. It should be assumed, though, that the first phases of this development, taking place in a single live protein molecule, may well take millions and millions of years and that such a molecule exhibits the features of life in such an inconspicuous manner that we may not become aware of its existence, even if we had it in our test tube.

Earth owes its life-favoring conditions to its atmosphere, its store of water, and its proximity to the Sun. The elements found on Earth are the same as those found on other celestial bodies. This can be verified by an analysis of the light which reaches Earth from other stars. The chemical compounds, however, are quite different on stars and planets. While the outer regions of the Sun consist mainly of hydrogen and helium and only traces of particularly hardy components like cyanogen, silicon fluoride, and titanium dioxide, the crust of Earth, and that of the planets, is made up of a great variety of chemical compounds. The relative abundance of these compounds is very probably the same on the solar planets and in all likelihood, also on the planets of other stars. This, however, is only true for the solid part of the planets. Their atmospheres and their water content differ very widely. It is this difference and their distances from the heat-providing central star which makes some planets suitable for life and excludes others very definitely.

The atmosphere of Earth fulfills a number of functions which are essential for the support of life. It provides oxygen for the animals and carbon dioxide for the plants. It carries rain to the remotest places. It moderates the impact of the solar rays during the daytime, and it keeps the surface of Earth from losing its heat too quickly during the night. It shields the living beings from ultraviolet and cosmic radiation, and it protects them against the countless meteorites which constantly shower Earth.

The animal organism, being constantly at work in one way or another, needs a continuous supply of energy. Oxygen, with its great affinity to exothermic reactions with many other elements, is an ideal source of energy. Nature chose the slow combustion of oxygen with other elements as the principal supply of energy for the bodies of animals. The fuel which is burned with the oxygen of the atmosphere is normally some form of plant or animal life. It is well known that the body of an animal could not subsist on the combustion of soot or crude oil, although the amount of heat energy per gram of those fuels is much higher than that of a gram of spinach. This fact indicates very clearly that the animal body does not only require calories for its subsistence, but also a specific kind of "molecular orderliness." This peculiar feature of animal organisms will be discussed some more in a future article.



The atmosphere of Earth has not always been the same throughout the several billion years of its existence. In the beginning, there was a great abundance of light gases, particularly hydrogen, helium, methane, ammonia, water vapor, and neon. However, Earth could not retain these gases while it was still very hot. They gradually drifted out into space, and we must assume that for some period during its development Earth was without an appreciable atmosphere. To understand the reason why a planet can lose its atmosphere, we must take a look at the structure of our atmosphere in general.

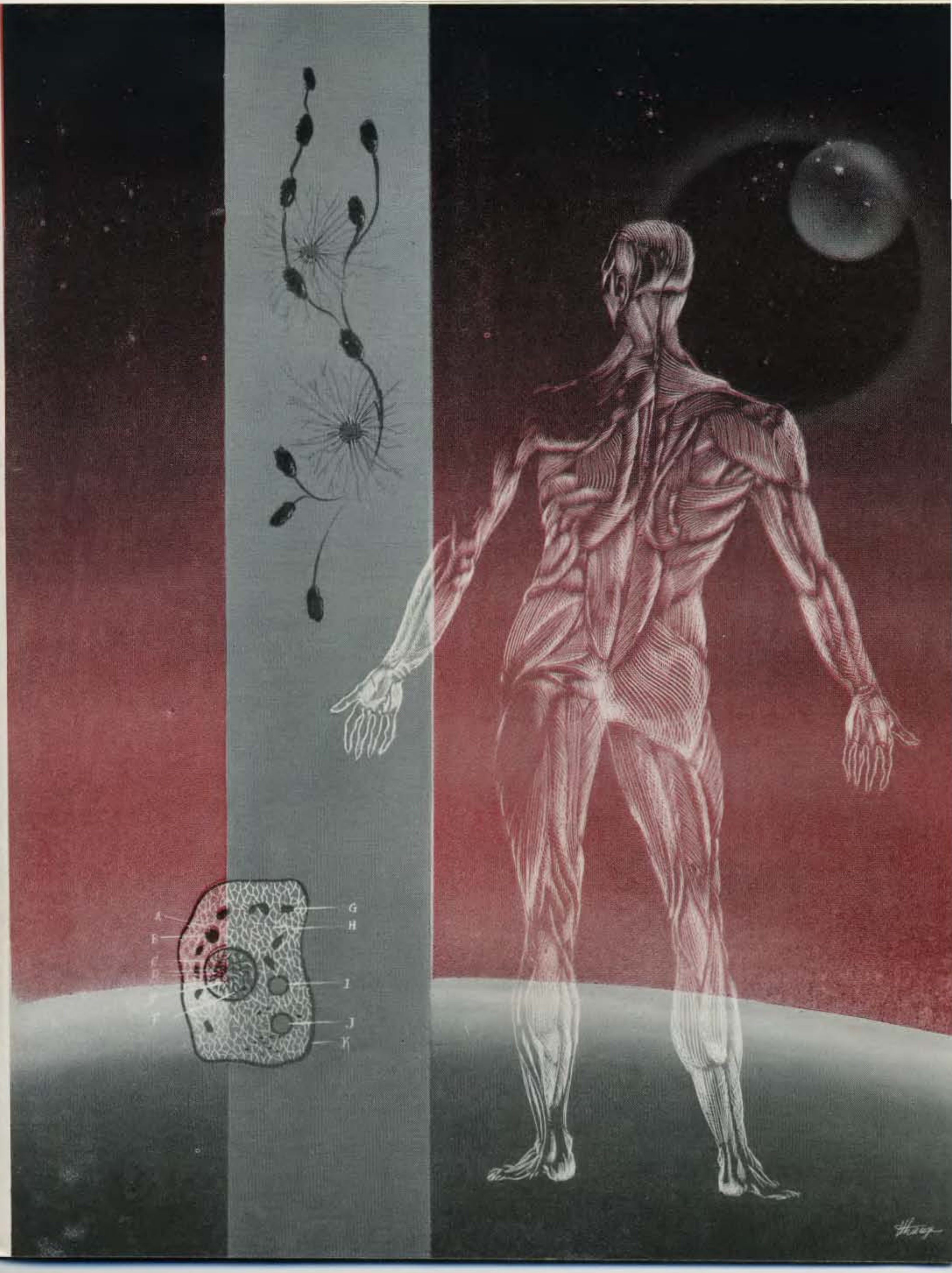
The molecules of a gas are in constant motion; their velocities and directions are distributed at random. Under conditions of normal temperature and atmospheric pressure, one cubic inch of air contains about a hundred billion billion molecules. Each of them collides with another one after a path of not more than a hundred thousandth of an inch, thereby changing its velocity and its direction. The average velocities of the molecules in a gas depend on the temperature: The hotter the gas, the higher the average velocity of its molecules. The mean molecular velocities of various gases are listed in table 1 for two different temperatures. Some of the molecules will always be faster than the average, others will be slower. The distribution of their velocities follows a so-called Maxwellian distribution curve.

The height of the atmosphere is not well defined. Its density decreases continuously on the way up, but even at an altitude of 200 miles we find still almost a billion molecules in each cubic inch. The path length between two collisions, however, has increased to many thousand miles. If at an altitude of a few hundred miles a molecule happens to acquire a particularly high velocity in a few favorable collisions, and if its direction is radially outward from Earth, it may well overcome the gravity pull of Earth's field and escape into outer space. The velocity needed for this escape is independent of the mass of the molecule, but depends on the mass and the diameter of the planet. Some characteristic escape velocities are listed in table II.

Although the average velocities of gases, even at higher temperatures, are generally lower than the escape velocities of Earth and other planets, there will always be molecules whose velocities, at one time or another, are sufficiently high to make them escape from their mother planet. In the course of millions of years, this gradual escape may well lead to a considerable rarefication, and even a total loss, of a planetary atmosphere. In the case of Earth, it did. It wās only much later, after Earth had cooled down, that a new atmosphere developed. Carbon dioxide, nitrogen, and water vapor were probably the main constituents of this new atmosphere. They were released from the crust as it slowly solidified. But there was still no oxygen in the air, and if there had been, it would have been consumed again in the oxidation processes of the rocks and minerals. There was some methane and ammonia, and this almost chaotic setting was probably the backdrop on which the first live protein molecules were formed. How this possibly may have happened, or at least what we can conjecture today, will be described in more detail in the next issue of SPACE Journal. It may suffice here to note that the first living organisms were probably small coagulations of protoplasma-like matter, capable of splitting carbon dioxide with the aid of sunlight. The carbon and a number of chemical compounds incorporating carbon were retained in the organism, and the oxygen was released. We must assume that the total amount of oxygen found in our atmosphere today was produced by plant organisms.

There would be even more oxygen in the air today if the plants, after their death and during their decay, had not used up so much of it in a slow oxidation process which finally resulted again in carbon dioxide. However, throughout the ages, much of the organic matter was buried deep in the ground where it was not exposed to the oxygen of the atmosphere. A considerable amount of oxygen was therefore left in the atmosphere, and huge reservoirs of coal and oil were built up simultaneously in the deeper layers of Earth's crust. It is very interesting to note that the total amount of oxygen in the atmosphere would just about be sufficient to oxidize the total amount of coal and oil still buried under the surface.

Animal life was able to develop on earth as soon as the oxygen supply was sufficient for its support. The animal organism depends for its food entirely—either directly or indirectly—on the existence of plant life. But, the production of carbon dioxide by the animals is such a small contribution to the large-scale production by oxidation of dead plant organisms that animals could not be considered essential for the existence of plant life. It is conceivable, therefore, that a planet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contains vegetation and no animals; but it is not to be expected that there are planets populated by animals and bare of any plant-like organisms.

It is by no means certain, of course, whether life will always develop into a plant branch and an animal branch. There are numerous species of living organisms even on Earth which cannot be counted under one of these branches. Viruses, bacteria, and even some of the protozoa, do not clearly belong to the plants or the animals. Some highly specialized parasites which live in the intestines of other animals require neither oxygen nor carbon dioxide nor light for their subsistence; they live on sugar or starch which they take from their immediate vicinity, and they produce energy not from oxidation, but from a process of fermentation which is controlled by special enzymes. These parasites, of course, depend on a live host. It may be assumed with a high degree of certainty that if life develops at all, it will at first be in the form of plant-like organisms which consume carbon dioxide and release oxygen, with the help of sunlight. Carbon dioxide and sunlight are therefore mandatory for the development of life. Water, too, is absolutely essential, not only as a source of hydrogen, but also as a solvent, and as a basis for the colloids which form the bulk of the structural materials of plant cells. Most of the transportation of materials inside a living organism, plant or animal, is done by diffusion or by osmotic processes; this would be unthinkable without water. With its large specific heat, water is an ideal thermostat which helps to equalize the temperature within one organism and which protects the organism against rapid changes in temperature. It is true that life can exist for long periods of time without water, as in dry spores or seeds. However, this is a latent kind of life only, and not the active development of living organisms. There are even mammals, like the little desert mouse, which never drink water during their whole life; they synthesize it out of carbohydrates and oxygen. Even though they can live without taking water, they procure it in an indirect way, for the seeds and other food which they eat could never develop without an adequate supply of water.

Life can only develop, and subsist, when the ambient temperature is favorable. The lower limit of the temperature range suitable for life is not only determined by the freezing of the liquids within the organism, but also by the rates of chemical and physiological reactions which, as a rule, depend very sensitively on the temperature. It is true that a living body can develop and maintain a temperature considerably higher than that of the surroundings, but the temperature gradients within the outer layers of the body can not be too great. Furthermore, active temperature control is a refinement that is achieved by an organism only a long time after it has developed the basic features of life. We may safely assume, therefore, that life develops only in regions where the temperature does not drop below the freezing point of water solutions. The high-temperature limit is set by the stability of large organic molecules. Any molecule can be broken up if the temperature is raised high enough. The large molecules which are found in living matter decompose fairly easily, many of them even below the boiling point of water. Most live organisms can be killed by boiling them in water. Some algae are known to live, and even thrive, in hot springs, but these organisms are highly specialized and certainly do not represent an original development. It should be assumed that an environment which allows temperatures below about -20°C (-4°F) and above $+80$°C (176°F) is not suited for the development of life.

With these restricting conditions in mind, we will now proceed to look at the solar planets as a typical planetary system, and we will ask which of them might be capable of bearing life.

TABLE 1

MEAN THERMAL VELOCITIES OF ATOMS AND MOLECULES AT DIFFERENT TEMPERATURES

	O°C	2400°
Hydrogen	1.15 mi/sec	3.4 mi/sec
Helium	0.82	2.4
Water Vapor	0.38	1.1
Nitrogen	0.31	0.9
Oxygen	0.29	0.86
Carbon Dioxide	0.25	0.74

TABLE II

ESCAPE VELOCITIES AT SURFACES OF PLANETS

	Mi/sec
Moon	1.5
Mercury	2.6
Venus	6.4
Earth	7.0
Mars	3.1
Jupiter	37.0
Saturn	22.0
Uranus	13.0
Neptune	14.0
Pluto	6.5

TABLE III

CHARACTERISTIC DATA OF PLANETS

PLANET	DIAMETER (MILES)	VOLUME EARTH: 1	DENSITY EARTH: 1	MASS EARTH: 1	GRAVITY EARTH: 1	TEMP. OF SURFACE Max. (°F)	LENGTH OF DAY (HOURS)	DISTANCE FROM SUN (SIDEREAL DAYS)	LENGTH OF YEAR (MILES x 10^6)	ORBITAL VELOCITY (MILES/SEC)
MERCURY	3,100	0.060	0.76	0.056	0.38	750°	2,105.85	87.96	35.9	29.7
VENUS	7,700	0.910	0.88	0.817	0.86	210°	718.23	224.70	67.2	21.7
EARTH	7,927	1.000	1.00	1.000	1.00	140°	23.94	365.25	92.9	18.5
MARS	4,215	0.151	0.71	0.108	0.39	90°	24.61	686.98	141.5	15.0
JUPITER	88,640	1,312.000	0.24	318.350	2.64	-200°	9.38	4,332.60	483.3	8.1
SATURN	75,100	763.000	0.13	95.280	1.17	-240°	10.03	10,759.53	886.2	6.0
URANUS	31,000	59.000	0.23	14.580	1.05	-270°	10.75	30,686.48	1,782.8	4.2
NEPTUNE	32,000	72.000	0.29	17.360	1.23	-330°	15.80	60,188.82	2,793.5	3.4
PLUTO	3,500	0.900	0.96	0.700	0.90	-370°	155.61	90,471.33	3,676.0	2.8
MOON	2,160	0.020	0.60	0.012	0.16-0.20	-240°	654.04	27.32	.24*	0.64

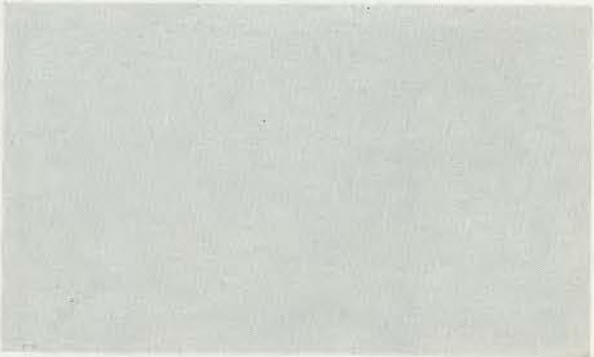
*DISTANCE FROM EARTH.

The amount of solar energy which is received by a given area is inversely proportional to the square of the distance between this area and the Sun. Mercury, for example, whose mean distance from the Sun is only about one-third that of Earth, receives almost nine times as much solar energy per unit area as Earth. Saturn receives almost a hundred times less. There is only a limited region around the Sun, and around each fixed star, within which a planet receives the right amount of solar radiation to make life possible. If a planet within this region has about the right magnitude, it could have developed an atmosphere which contains at least water vapor and some other gases like nitrogen and carbon dioxide. This atmosphere in turn would equalize the temperature sufficiently so that an environment favorable for the development of life would result. H. Strughold has named this favorable region around a fixed star the "ecosphere." Our Earth happens to be right in the middle of the Sun's ecosphere. Venus is at its inner, Mars at its outer margin.

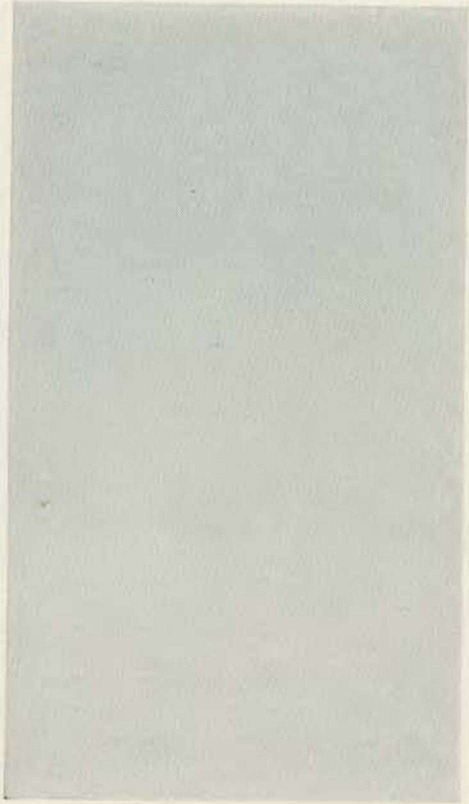
Mercury, our smallest planet, (see table III) is unsuitable for life. It has the peculiar feature of always turning the same face toward the Sun, very much like the Moon always looks toward Earth with the same side. The bright side of Mercury, having eternal day, is heated up to a surface temperature of about 400°C (750°F). The "night" side, which is permanently in the shadow, is extremely cold. There is a very broad twilight zone between the hot and the cold regions because of angular oscillations of the planet; in this zone, the temperature varies widely up and down during the Mercurian year. If there is any atmosphere on Mercury—and there are optical observations which imply that there is some—its pressure is not greater than about 1/800 of that on Earth. Mercury is simply too small, and too hot on its sunny side, to retain an appreciable amount of gas as an atmosphere. It is probably mountainous, but travellers to Mercury will find nothing except "a lifeless, desolate world, with a surface parched and cracked" (Patrick Moore).

Venus, one of the most beautiful sights in the evening or morning sky, has been veiled in mystery as long as astronomers have turned their telescopes toward it. A dense atmosphere, opaque to optical observation, covers the entire planet. It is not known what this opaque gas layer consists of, but it is probable that it contains carbon dioxide, and possibly large clouds of dust. But what does it hide? Since no water vapor can be detected in the outer layers of the atmosphere of Venus, it was assumed in the past that Venus is an entirely dry and desert-like planet, whipped by terrific storms and shrouded by a permanent layer of dust clouds. Whipple and Menzel recently suggested that the entire surface of Venus may be one large ocean of water. In this case, it is not impossible that there is some kind of aquatic life on Venus. The temperature of the water would be high, but it would be below the boiling point. There is only little hope that we will learn much more about the surface of Venus until our first interplanetary spaceship circles the planet and sends sounding rockets through its atmospheric blanket.

The Moon is an entirely inhospitable place. Although it receives the same solar energy per unit time and area as Earth, there is certainly no life on the lunar surface. The temperature on the sunlit side goes up to about 120°C (250°F). In the shadow, it drops quickly down to — 150°C (— 240°F). There is no atmosphere which could equalize these large temperature differences. Even if there had been some gases during its early development phases, the Moon would have lost them very rapidly because of its small size. There might be minute traces of very heavy gases like krypton or xenon, but their existence would be insignificant for the development of life.



Mars is always named first when life on other planets is discussed. Its surface conditions are more like terrestrial conditions than those of any other known planet. Speculations about the forms of Martian life have been numerous and fantastic, and there is almost no limit to the weirdness of the Martian monsters which have been conjectured by inventive minds. Astrobiologists are now more cautious. They do not expect more than some modest, but very resistant forms of plant life, such as we find on Earth in the dry and rocky areas of the far north. The green patches which can be seen on the Martian surface, together with the relatively low temperatures + 20°C (+ 68°F) during the day, but only — 70°C (— 94°F) during the night according to G. de Vaucouleurs and G. P. Kuiper) imply a possible vegetation similar to mosses or lichens. The atmospheric density on Mars is only one-tenth of that on Earth. It contains nitrogen and carbon dioxide, but almost no oxygen. The water content of the Martian atmosphere is only a few percent of the moisture in the atmosphere above terrestrial deserts. Animal life similar to that on Earth would not be possible. A very interesting suggestion has been made by H. Strughold: it is possible that plants on Mars store the oxygen resulting from their metabolism within their tissues, thereby building up a kind of "internal atmosphere." Plant types different from ours could thus develop, and even specialized forms of animal life, drawing oxygen directly from the plants, would not be utterly impossible. However, conditions for life are not overwhelming on Mars. As H. Strughold put it, Mars has always been, and will always be, an "underdeveloped planet," as far as life is concerned. It is just a little too far away from the Sun. The greatest distance from the Sun is even much more significant for the rest of the planets. Jupiter, Saturn, Uranus, and Neptune are large enough to retain even the lightest gas, hydrogen, in their atmospheres. However, their surface temperatures are so extremely low (see table III) that none of the processes which are essential for the development of life could possibly take place. The mean densities of these four large planets are surprisingly low; the logical explanation is that considerable portions of their observed sizes are made up by atmospheres of great depth. The water, which exists unquestionably in great quantities on these planets, must be frozen. In fact, it is assumed today that each of the four



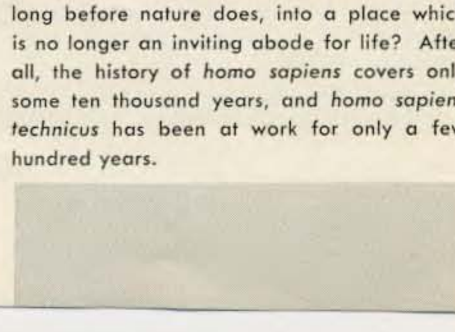
major planets has a rocky core which is covered by a layer of ice several thousand miles thick; their atmospheres above the ice coating also have depths of several thousand miles. These figures are implied by the low densities, the observed diameters, and the very pronounced flattening of the planets. The atmospheric pressure at the surface of Jupiter is about a million times greater than the atmospheric pressure at the surface of Earth. Even at much lower pressures, all gases are liquid or solid, or at least have densities equal to their densities in the liquid or solid state. The term "atmosphere" is therefore misleading; only the outermost few hundred miles of the "atmospheres" of these planets can be expected to be gaseous. Again judging from the observed densities, it must be assumed that these outer layers consist of hydrogen or helium. Jupiter and Saturn contain, in addition, fairly large quantities of gaseous ammonia. All four planets are rich in gaseous methane. Most of the ammonia, however, is frozen; the same is true for carbon dioxide, which should not be expected in gaseous form. No gaseous nitrogen or oxygen should be expected either.

We need not hope to find any traces of life on one of the four major planets. The temperatures are far too low; there is no gaseous oxygen or carbon dioxide; there is no liquid water; there is an abundance of the poisonous gases ammonia and methane. Their surfaces are deserts of frozen gases, hostile to any possible form of life. It is hard to imagine how future space travelers could ever set foot on one of these planets. They will only orbit around them at respectable distances, sending their unmanned sounding probes down into these oceans of hydrogen, helium, methane, and ammonia. The rocky core of these planets will probably never be accessible to man.

Little is known about the last and remotest planet, Pluto. It is too far away for meaningful, direct observations. But even without knowing too much about its surface conditions, the possibility of life can be excluded because of the extremely low surface temperatures.

Among the nine planets of the Sun, there are three whose orbits are within the ecosphere; but only one of them, Earth, exhibits such a favorable combination of properties that life could develop on a grand scale. Venus may bear some aquatic life; Mars very probably carries low forms of vegetation.

How long will Earth continue to offer these favorable conditions? Within the next billions of years, the Sun will heat up and expand and eventually will extend its white hot atmosphere beyond the planetary orbit of Earth. But long before that time, Earth will have lost more and more of its atmosphere. Within the next several million years, the atmosphere will gradually drift away into outer space. When the gaseous oxygen and carbon dioxide are significantly rarefied, animal and plant life in its present form will no longer be possible. Will life by then have developed into forms which can subsist under the changed conditions? Will man have found other ways to prevent the gradual decline of favorable living conditions? Will he change his Earth, long before nature does, into a place which is no longer an inviting abode for life? After all, the history of *homo sapiens* covers only some ten thousand years, and *homo sapiens technicus* has been at work for only a few hundred years.



the acid test

By Wernher von Braun

Wernher von Braun was born on March 23, 1912, in Wirsitz, Germany. He acquired his doctorate in physics at the University of Berlin in 1934. In the spring of 1930 he joined Professor Hermann Oberth and assisted him in spare hours in Professor Oberth's early experiments with liquid fuel motors. He was Technical Director of the Liquid Fuel Rocket and Guided Missile Center at Peenemuende from 1937 until the end of World War II. The V-2 rocket was developed at Peenemuende and the first successful V-2 was launched in 1942. Dr. von Braun has been Technical Director of the Army Ballistic Missile Agency since 1956. He is married and has two daughters. His publications include *The Mars Project*, *Across the Space Frontier*, *Conquest of the Moon*, and *The Exploration of Mars*.

The acid test of men and nations is the measure of their courage and resourcefulness in the face of adversity and peril. Those which have survived crises have exerted the most profound influences upon mankind's destiny. Those which failed did so because they could not manage abundance and power.

Our country has faced agonizing tests more than once during its relatively short history. It emerged each time from the crucible not without scars but with greater confidence and richer maturity. America survived crises because it knew what must be done and did it without regard to consequences, with faith in its own judgment and in the resources which had to be marshalled for the common good.

Even now we are experiencing another test. Historians may record it as one of the most fateful intervals of the twentieth century which has certainly had more than its share of historic events. The early days of October 1957 marked a turning point in our destiny and that of other nations, large and small. An unprecedented technological achievement suddenly transformed a troubled but familiar world into one of strange and foreboding aspect. As it has, since the dawn of the Industrial Revolution, science had influenced history, and directly shaped the lives of men.

The reaction to these events has been profound. They triggered a period of self-appraisal rarely equalled in modern times. Overnight it became popular to question the bulwarks of our society: our public educational system, our industrial strength, international policy, defense strategy and forces, the capabilities of our science and technology. Even the moral fiber of our people came under searching examination. Since the evident threat was to our security, the initial preoccupation concerned modern weapons systems and means of defending against them. The Damoclean sword menacing free people consisted of a monstrous destructive force inherent in automatic delivery systems, capable of transporting thermo-nuclear warheads over thousands of miles, in *any* weather, across all geographic and political barriers, at velocities of such magnitude as to imply total destruction without advance warning.

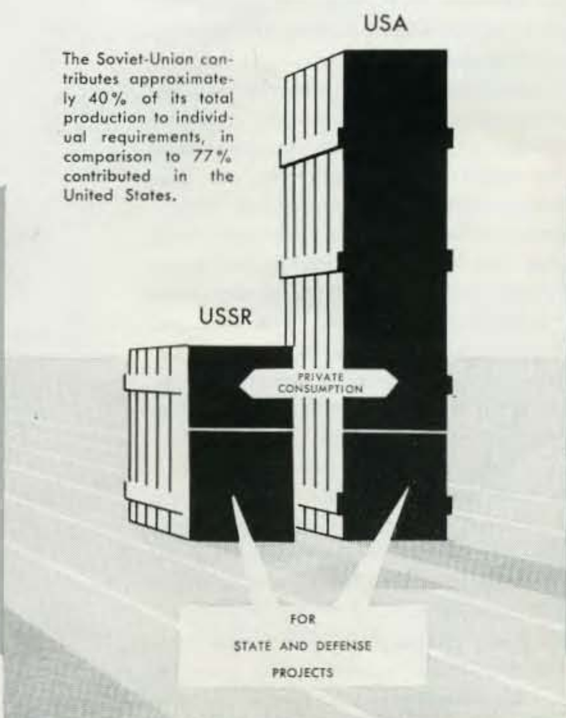
The logical process of evaluating our position has been underway ever since: first, to determine if we possessed these weapons, and what means of defense could be erected. Actions have been taken by the Defense Department, fully supported by the Congress, aimed at achieving operational capabilities with the intermediate and intercontinental ballistic missiles at the earliest practicable date.

Perhaps it is time now, without muddying the waters further, to determine whether we have correctly assessed the total threat represented by a totalitarian regime, whose end objective is world domination.

The Soviet challenge is by no means restricted to military technology. It goes far beyond the realms of politics and armies. No longer is the task of coping with the Red menace the exclusive responsibility of generals and statesmen. The acid test involves every facet of our civilization, every part of our society: religion, economics, politics, science, technology, industry and education. Free men everywhere have been caught up in this grim competition. We who enjoy our homes, drive the family car, spend more time in leisure and less in work, and pay less attention to national affairs than to television shows, are faced with a decision—will we do whatever is necessary to win this struggle, or will we continue in our comfortable illusion and thus court the risk of a defeat which would forever eliminate freedom, and place our children and their children under the control of an all-powerful state? What we are about to discover is whether a nation, which has rated its home run sluggers and its fullbacks above its scientists and philosophers, can meet the total competition of aggressive communism, and still preserve its way of life.

It will not be enough to perfect weapons systems which have at least equal capability with those of a potential aggressor. Others have pointed out that the deterrent effect of these machines of war may cancel the possibility of total conflict. It has been argued that this will turn aggression into another direction: that is, to the perimeter or brush-type war, in which the huge rockets of great range and mass destructive capability would *not* be employed. Against this estimate, the Army has reshaped its striking forces and equipped them with battlefield rockets and guided missiles. The urgent need of an adequate defense posture capable of dealing with any type emergency has met a rare degree of unanimity here and abroad.

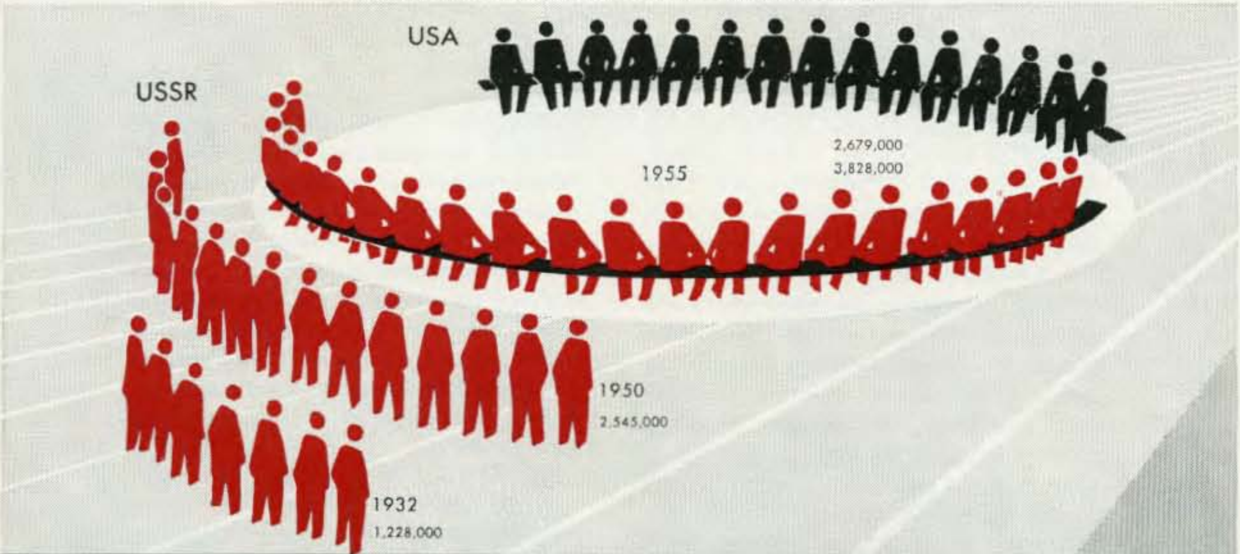
In sharp contrast, however, wide disagreement has developed over the real significance of the best-publicized exploit of Communist engineering—the Earth circling satellites whose monotonous signals were intentionally audible to listeners everywhere on Earth. Skeptics, who refuse to accept the possible until it has been demonstrated, have clouded the issue. This is a dangerous state of mind in a day when breakthroughs occur so rapidly that obsolescence of complex weapons systems has become a primary concern.



The Soviet-Union contributes approximately 40% of its total production to individual requirements, in comparison to 77% contributed in the United States.

DISTRIBUTION OF PRODUCTION

STUDENTS IN UNIVERSITIES AND TECHNICAL SCHOOLS



THE RISING GENERATION OF SPECIALISTS

Perhaps the launching of the Explorers helped to redeem our promises, but no amount of explanation or justification can show why we did not do it ahead of the Soviets—and no amount of mutual backslapping that we succeeded with Explorer on the first try can hide the fact that we have lost a round. We cannot afford to lose much more. It was a grave error in judgment to fail to recognize the tremendous psychological impact of an omnipresent, artificial moon visible to anyone with a good pair of eyes and audible to anyone with a simple radio receiver.

Another grave error was the failure to evaluate realistically the research, development, engineering and production capabilities of a totalitarian state. This lulled us into complacency and led to an underestimate of our adversary—risky business in any competition.

Since I had the dubious privilege of living and working under a totalitarian government for many years, I should be able to discuss this topic with some degree of competence. Anyone who says that science and technology cannot flourish in a police state does himself and his country a great disservice. It is generally recognized, of course, that personal freedom of movement and thought, and a free exchange of ideas, are essential to scientific advance. From this, however, many erroneously conclude that genuine scientific work is impossible in the climate of dictatorship. Let me clear up this notion once and for all, in the interest of arriving at an honest appraisal of our situation, by citing my personal experience at the Peenemuende Rocket Center in Hitler's Germany.

Neither I nor any of my associates were ever required to submit a travel itinerary in advance, whether for a short business trip or a vacation lasting several weeks. Throughout the war we had intimate, continuous contact with 36 universities and technical institutions. They performed research in support of our missile programs under contracts so broadly worded that they permitted the institutions an extremely wide latitude in implementation.

Discussions and symposia, quite similar to those conducted in this country, were held frequently. Many ideas were generated in this truly liberal academic environment. True, these ideas related exclusively to our technical concerns and not to politics, but they are successfully applied even today in rocket and missile activities. As far as personal freedom of movement is concerned, as well as free exchange of ideas in the strictly scientific and technological sphere, it would thus simply be misleading to assume that things were much different than in a free country.

The heavy hand of dictatorship is rather felt in another area. In Peenemuende, the security police kept dossiers on all of us, listing all the things we might have said about the regime or individuals of the upper hierarchy. Personal vices and weaknesses were catalogued in their files. But they left us alone as long as our usefulness, in their opinion, was greater than our debit account. Once they felt they could do without you and you were in their way, they'd call for the dossier and destroy you. It was that simple.

I realize that this sounds quite awful to men who have never experienced it. But the sober fact is that people, whether scientists or candlemakers, learn to live with such a situation. We don't deny ourselves week-end auto trips in spite of the National Safety Council's warnings about multiple deaths. Just so the man living under dictatorship adjusts himself to business-as-usual, whether he likes it or not, because he must in order to survive. Something like seven hundred million people are living today under Communist rule and, in all probability, they have learned to live in the face of such possible "road accidents."

Consequently, we should disabuse ourselves of the dangerous myth that the impotent Russian scientist bends over his slide rule with a gun pointed at his head. It appears that he enjoys at least as much reward as the American scientist and that, until quite recently, he had even greater latitude in his selection of resources and assistance.

We must consider, in this measure of the forces arrayed against us, the overall postwar era in such areas as atomic and thermonuclear bombs, nuclear power plants, jet aircraft, guided antiaircraft missiles and long-range rockets.

When we consider their low general technological status, as evidenced during the last war, plus the tremendous physical damage inflicted upon the Soviet industry by the war itself, it becomes frighteningly clear that their rate of progress greatly exceeds ours.

The real peril lies in the enormous momentum they have built up, which certainly will yield other dramatic by-products along the way. They have long since embarked upon a dynamic program to achieve supremacy in science and technology. Their state-controlled educational system is turning out competent engineers and scientists in greater numbers than ours. It is upon this broad foundation that the Russian is waging his effort and not upon the gleanings of the brain-picking of some captive, foreign scientists as many people in this country still seem to believe. Clearly we must accelerate our effort at a rate calculated to overtake and surpass the Russian advantage. And this calls for a sacrifice of an unprecedented scale.

It must be understood also that the Soviets have grasped the significance of man's imminent conquest of space and have proceeded well along the road in that direction. A current estimate of the situation would include these possibilities.

First to launch their satellites, the Russians probably used a multi-stage rocket which was originally designed to carry a thermonuclear warhead over intercontinental range.

Second, the same rocket configuration, with minor modifications, can place a payload of between 50 and 100 pounds on the moon.

Third, the rocket can also put up a satellite capable of military reconnaissance, equipped with a television playback feature. A few such orbital devices can keep track of the progress of all surface construction projects, ship movements, and air base operations anywhere in the world. Once they achieve this, and I am convinced that it is only very few years off, "open skies" inspection for purposes of disarmament becomes academic.

Fourth, the Russians have a sound program designed to solve the question of safe return from orbital flight and related space medical problems, with the purpose of preparing for manned space travel.

I would recommend that we brace ourselves for other Soviet "firsts" in the new field of astronautics. We are behind and we cannot catch up in a day or two, since major technological projects necessarily involve lead time. It will require several years of concentrated effort for us to come abreast, and even longer to pull ahead.

We can waste no time commiserating over the sorry lot of the Russian worker or peasant, comparing his lack of freedom and creature comforts with our prosperity. We should also "shuck off" another illusion, that the Russian people will rise up to overthrow the Kremlin and thus relieve us of all our worries. Perhaps a dream of freedom exists in the Soviet Union.

Perhaps, by exposing more young people to scientific training, a search for truth will be generated which will eventually reach against the dictatorship. But we cannot stand around, hands in pockets, waiting for others to do what can only be accomplished by us. I am convinced that it is man's destiny to enter space and that he who controls the open space around us is in a position to control the Earth. The only choice left us is to accept the Soviet challenge or "pay the piper."

I certainly do not suggest that we move into space with any belligerent intentions. It would only be consistent with the fundamentals for which the United States stand, if we would propose to the United Nations the universal acceptance of the principle of the freedom of outer space—in analogy with the principle of the freedom of the seas.

But any such doctrine would be void and meaningless if we cannot back it up with a position of relative strength.

It has been said that with the Sputnik Khruschev and Company launched their eventual downfall because this country reacted by firing up its missle and space programs.

And indeed, in more than one aspect this may be our last chance. In the first World War, as well as after Pearl Harbor, the United States had time to marshal her resources. Even in Korea and now, after Sputnik, we had time to initiate the necessary counteraction. Next time, in this world of long-range ballistic missiles and thermonuclear warheads we may not have time. Either we will be ready at a moment's notice, or historians may conclude over the ruins of our cities that we were "weighed and found wanting."

I hope that we will not conclude that money alone will turn all the tricks—there are other factors involved which cannot be settled so easily. It would be presumptuous for me to offer "school solutions," or even to list all the things which must be considered. But there are some minimum requirements which can be identified and which demand prompt action.

Our educational offerings must come under scrutiny since it is tomorrow's generation which will have to cope with the problems developing today. If their preparation is to be compatible with the kind of world they will inhabit, our young people must be taught basic and essential knowledge at the earliest practicable age—in the elementary schools. We have teachers we need, who can provide the ingot to disabuse ourselves of the idea that school is a place solely to teach boys and girls how to live together. They must understand mathematics and the physical sciences, which means more and better teachers and expanded offerings both in scope and number. Better salaries, improved professional status, and more adequate classroom and laboratory facilities are essential to obtain the kind of spirational leadership to interest young minds in facts.

I do not believe the Federal government will or should attempt to dictate such a program, but it should establish generally recognized educational standards and it should assist in a pump-priming role in the public schools and in our colleges and universities. Education in a democracy is the concern of every citizen. The people must insist upon a redirection of emphasis and willingly accept their just measure of responsibility for execution of our educational programs. To all who ask, "What can I do to help?", my answer is to take active interest in *what* is being taught, *how* it is being taught, and by *whom*.

There has been unnecessary concern about possible Federal interference in local schools. The Federal government as well as the states have been supporting public education in greater or lesser degree for years—all we are talking about is funneling support into more productive channels. If the Federal government can support highway projects, why not schools?

Finally, we must generate the will to supremacy. Because this is intangible—because it must come from the hearts and minds of our people, it cannot be legislated, budgeted or evoked by decree. We want no Federal propaganda machine exercising dominion over the free press. We want no dictator telling us what to believe and what to do. But we must set about learning the facts and, when we have understood them, buckle down to the challenging tasks which confront us.

We should stop telling the world what we are *against*. We should tell the world what we are for. We must not fight the communist ideology with negative statements, but with the lofty ideals of the founders of this great republic. The antidote to communism is not anticommunism, but the belief in God and the dignity of the individual. Let us not deceive ourselves; the communist ideology has a powerful appeal to the have-nots, the uninformed, and the desperate. But ideas are fought not with material means, but with superior ideas. And where should these ideas be found in this world today, if they cannot be found in this glorious land of the free? The flag of leaderhip of the free world has been thrust into the hands of Americans. Let us live up to the historical challenge.

We must think in terms of long-range objectives, not on the time scale of next year's automobile models. We must put our trust in men assigned to carry out these programs, and not interrupt or divert them by frequent reexaminations or demands for justifications. We must supply them with the resources they require, hold them responsible for results, and leave them alone to carry out their missions. We must look for, and demand, competent and honest reporting, the hallmark of American journalism, which is sometimes lost sight of by a small segment of the press bound to carry out propaganda attacks or sales campaigns by self-serving interests.

If we can inspire a national determination to achieve the ultimate victory, all other factors will fall into their proper perspective and places. We will then move forward, a united people, into an age in which the far reaches of the universe will become as familiar as the next town.

It is disquieting to be asked "But what will all this profit us?" Such questions betray a lack of confidence and, even more serious, the kind of unenlightened approach which has hamstrung our progress in the past. No man can say with assurance, what benefits will accrue from our discoveries. With Explorer I, we made a modest beginning. We have stepped into a new, high road from which there can be no turning back. As we probe farther into the area beyond our sensible atmosphere, man will learn more about his environment; he will understand better the order and beauty of creation. He may then come to realize that war, as we know it, will avail him nothing but catastrophe. He may grasp the truth that there is something much bigger than his one little world. Before the majesty of what he will find out there, he must stand in reverential awe. This, then, is the acid test as man moves into the unknown.

books recent and forthcoming

Reviewed By
Ralph E. Jennings
Hoffman Birney
M. Raymond

Hoffman Birney, a Philadelphian by birth, has been associated with the guided missile program since 1947 when he transferred to Fort Bliss as technical editor for the Ordnance Research and Development Sub-Office Rocket. He is a writer of wide experience and author of some 25 books—fiction, biography, travel, and historical novels. He has been on the staff of the *New York Times Book Review* for nearly twenty years and conducts a monthly column which reviews current western books.

Exploring the Distant Stars. By Clyde B. Clason. 384 pages. New York: G. P. Putnam's Sons. $5.

The Next Fifty Billion Years. An Astronomer's Glimpse into the Future. By Kenneth Heuer. 144 pages. Illustrated by Chesley Bonestell. New York: Viking Press. $3.

It is a welcome coincidence that these two volumes should reach the reviewer's desk on the same day. Mr. Clason's popularized treatise on astronomy covers that science from Aristotle and Hipparchus to Fred Hoyle and vaults the heavens and the cosmos—the terrible emptiness of space, in Clason's apt phrase—from our neighbor Luna, less than a quarter-million miles away to dim galaxies that are merely dreamed of as existing beyond the 200-billion light-year range of the Palomar two-hundred-inch telescope or the even longer range of the radio instruments which explore "the vision of the world and all the wonder that would be."

Mr. Heuer limits his discussion to our own insignificant little globe and the possible—not the probable!—circumstances under which it might end its currently four-billion year old existence.

Mr. Clason's book—if the opinion of a very nonprofessional astronomer is acceptable—takes in too much territory. The chapters on the constellations and on the stars, galactic and extragalactic, from our own Sun to far, far, faraway S-Doradus (it's one million times as bright as our Sun) in the Large Magellanic Cloud—those chapters are so condensed that the reader finds himself floundering in a maze of white dwarfs, red giants, and Cephied variables.

This reviewer would be first to admit that this criticism is unfair and is the product of his own ignorance. At the same time, it must be admitted that "Exploring the Distant Stars" takes in just about all the territory, universal, galactic, and cosmic, that there is.

Kenneth Heuer, F.R.A.S., has delivered more than a thousand lectures at the Hayden Planetarium, New York. His book discusses the various fates which have been advanced as the possible end of the world. The Moon might approach so closely that tidal waves will overwhelm the continents, or in even closer approach our satellite might shatter into a million or two fragments which would destroy the world in a shower of supershrapnel. We might perish in a collision with an errant asteroid, with the glowing head of a comet, or even in a head-on collision with another star of a magnitude as great as the Sun. It's possible that the end might come when the Sun's fire dies and mankind vanishes beneath the mantle of another Ice Age or—the opposite extreme—when the Sun blows up as a nova or even a supernova.

All of these are natural phenomena. All are remotely possible but very far from probable and so far in the future that no one need worry unless he expects to be around this particular sphere forty or fifty million or billion years from now.

"Here the disastrous effect on just one city—Chicago, Illinois—of the Sun's exploding is shown. Lake Michigan and the Chicago River have aready boiled away." (Chesley Bonestell illustration from THE NEXT 50 BILLION YEARS.)

"The Earth is struck by a small comet whose head is about 10,000 miles in diameter." (Chesley Bonestell illustration from THE NEXT 50 BILLION YEARS.)

"The Moon may be drawn back to the Earth in the remote future. At a distance of 20,000 miles, it will begin to break up, raining huge meteors on the earth." (Chesley Bonestell illustration from THE NEXT 50 BILLION YEARS.)

However—and here is where you and I and the Australian aborigines are definitely concerned—Mr. Heuer gives us to think over the possibility that man himself might pull the suicidal trigger! If man persists—as man seems to be persisting—in experimenting with hydrogen atoms, with fission and fusion, with cobalt casings and worldwide fallout, then you can write your own ticket against the day when some junior-grade Rasputin dares the free world to play his own brand of Russian roulette.

It is something to think about, but in the meantime, here are two books which belong in the library of every astronomer, professional or amateur.

—Hoffman Birney

Science and Human Values. By J. Bronowski. 94 pages, New York: Julian Messner. $3.

It is quite fitting that this volume is illustrated with works created in the metaphysical imagination of William Blake. "Poetry," writes Mr. Bronowski, "does not move us to be just or unjust, in itself. It moves us to thoughts in whose light justice and injustice are seen in fearful sharpness of outline." Tolerance among scientists cannot be based on indifference; it must be based on respect, Mr Bronowski says. Respect as a personal value implies, in any society, the public acknowledgments of justice and of due honor. These are values which to the layman seem most remote from any abstract study. What, the layman may ask, have human values such as justice, honor, and the respect of man for man to do with science? "The question," replies Mr. Bronowski, "is a foolish survival of those nineteenth-century quarrels which always came back to equate ethics with the Book of Genesis." He says that science confronts the work of one man with that of another and grafts each on each; and it cannot survive without justice and honor and respect between man and man. Only by these means can science pursue its steadfast object, to explore truth. If these values did not exist, Mr. Bronowski believes, then the society of scientists would have to invent them to make the practice of science possible. In societies where these values did not exist, science has had to create them.

What power holds the company of scholars together? In answer to his rhetorical question, Mr. Bronowski replies that, in an obvious sense, theirs is the power of virtue. All scholars in their work are of course oddly virtuous by the worldly standards of public life. They do not make wild claims; they do not cheat; they do not try to persuade at any cost; they appeal neither to prejudice nor to authority; they are often frank about their ignorance; their disputes are fairly decorous; they do not confuse what is being argued with race, politics, sex or age; they listen patiently to the young and to the old who both know everything. Concerning this, Mr. Bronowski writes: "These are the general virtues of scholarship, and they are peculiarly the virtues of science. Individually, scientists no doubt have human weaknesses. Several of them may have mistresses or read Karl Marx; some of them may even be homosexuals and read Plato. But in a world in which state and dogma seem always either to threaten or to cajole, the body of scientists is trained to avoid, and organized to resist, every form of persuasion but the fact. A scientist who breaks this rule, as Lysenko has done, is ignored. A scientist who finds that the rule has been broken in his laboratory, as Kammerer found, kills himself."

Much of Mr. Bronowski's thinking can be said to follow Kant's categorical imperative. It is quite apparent that he considers man, with his tragic dignity, to be an important little creature in the scheme of things. Regardless of where man is destined to go, this reviewer is reminded by Mr. Bronowski's book of the line by the poet Rilke who, after seeing Picasso's painting, "The Saltimbanques," wrote: "But tell me, who are they, these acrobats, even more fleeting than we ourselves. . .?" In an age of cynicism, Mr. Bronowski's book is refreshing. This reviewer recommends it.

—Ralph E. Jennings

The Space Child's Mother Goose. By Frederick Winsor. Illustrated by Marian Parry. New York: Simon and Schuster. $3.50.

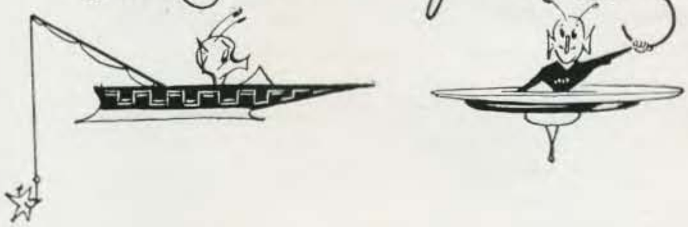
The author of this space child's hydroponic garden of verses apologizes, in his dedication, ". . . if it's *vieux jeu* and it leaves you cold. Forgive us, darlings, We're Awfully Old."

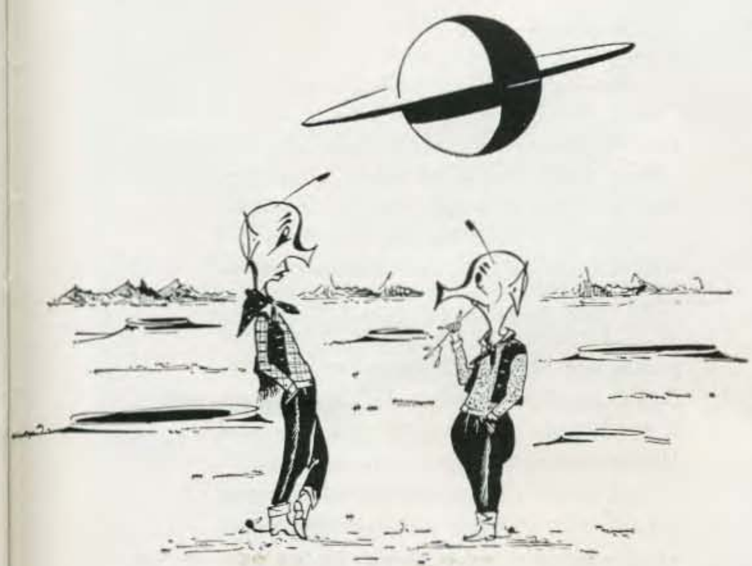
These poems are not really *vieux jeu*, but in all probability they will leave the darlings cold because they are written for space parents—and extremely intellectual space parents at that. Even so, many of the poems have a whimsical twist that is provocative and delightful; for example, a poem illustrating the hypersonic genesis of today's Everyman:

Solomon Grundy
Walked on Monday
Rode on Tuesday
Motored Wednesday
Planed on Thursday
Rocketed Friday
Spaceship Saturday
Time Machine Sunday
Where is the end for
Solomon Grundy?

—M. Raymond

out our space





Yep—New York sho is a nice place, but I wouldn't want to live thar.

ADVENTURES OF "LASKA"

vox populi

In order to prevent delays, all reaction mail and manuscripts submitted to SPACE Journal must be addressed to SPACE Journal, P.O. Box 82, Huntsville, Alabama. Similarly all subscriptions or inquiries concerning subscriptions must be addressed to SPACE Journal, P.O. Box 94, Nashville, Tenn.

Dear Editor,

Thank you very much for the copy of the spring edition of SPACE Journal, which is dedicated to my late husband.

You have every right to be proud of your publication, and to be particularly proud of the article about my husband. It is one of the very best that will be in the book I keep for published stories about him.

With congratulations on this fine story, and appreciation of your courtesy, sincerely

Worcester, Mass. Mrs. Esther C. Goddard

Dear Editor,

I have read your first issue of SPACE Journal very completely and from my observation I would like to state that of all such publications on the market, yours is by far the most superior. I offer my congratulations for a terrific job. . . . .

W. A. Shuping
Director of Operations
Missile, Rocket and Space Division
Vitro Corporation of America
Martinsburg, W. Va.

Dear Editor,

I enjoyed your spring issue very much, but I would like to call your attention to figure 4, page 12. I am sure that you will find that it is not the Crab Nebula but that it is the Whirlpool galaxy (sometimes called Whirlpool Nebula), M51, as listed in Charles Messier's list.

Nashville, Tenn. Frank H. Reeves

Dear Editor,

Your Vol. 1, No. 2, of SPACE Journal has just fallen into my hands. As I am a science teacher in the Lake Geneva High School, I was very interested to see what you had to offer.

. . . I was shocked however to find that the photograph on page 12, figure four, was captioned the Crab Nebula. This must be an error. It looks more like M51, the Whirlpool Nebula in Canes Venatici. . . .

I am also the sponsor of the Lake Geneva science club. My club members have asked about starting a rocket division in the club. Now I am well aware of the dangers that lie in such an operation, and I do not want anyone to get hurt.

I have told my people that I do not want them to build any overnight rocket and that there is little to be gained from just throwing something together and shooting it off. I want a lot of study to go into such a thing before it is done, if ever.

Frankly I would like some good sound advice on how to proceed with the organization and operation of such a club. I know nothing about rocket fuels except that they are very touchy and dangerous to handle. Is there some kind of program that we can undertake that would interest the club members and still be safe and constructive?

Photo Service Department Donald W. Carter
Yerkes Observatory
Williams Bay, Wisc.

Readers Reeves and Carter, and a host of others, are correct in identifying the illustration on page 12 as the Whirlpool Nebula, or M51, in Canes Venatici. The mix-up occurred when the staff was attempting to rush the second issue through the printers after celebrating the successful orbiting of Explorer I. While this is certainly no valid excuse, we feel that the circumstances were at least mitigating. As for reader Carter's science club and its activities in rocketry, I urge you not to attempt to build rockets propelled by any form of explosive, such as black powder, homemade mixtures based on powdered metals, compressed gasses, etc. You should begin by studying the basic physical principles which underlie rocketry. It may not sound inviting or exciting to begin a project in rocketry by reading physics. However, you will find that your project will take on new depths of meaning and possibilities as you delve into these basic principles. Only after you have mastered the fundamentals and have become completely familiar with the deadly power of even the most simple explosive will you be ready to attempt the construction of rockets. Editor.

Dear Editor,

Our group has recently become very interested in the properties of space. We found some questions for which answers were unobtainable. Since we have heard of your magazine, we wondered whether you could be of assistance to us. Would it be possible for man to adapt himself to the moon in a great number (perhaps millions) of years?

We would appreciate any aid which you could supply on this subject.

Ridley College
Ontario, Canada

Joe F. Law

In answer to your question "Would it be possible for man to adapt himself to the moon in a great number (perhaps millions) of years?", I must give you both a yes and a no, qualifying each according to my interpretation of your question.

The answer is no if you are thinking about adaptation by way of what we call evolution since all forms of life, as we know it, require oxygen.

If you mean by adaptation man's ability to create artificial environmental conditions on the moon which will eventually permit establishment of experimental scientific laboratories, mining, factories, and even cities, the answer is a very positive yes. Editor.

Dear Editor,

Since the first issue of SPACE Journal was dedicated to Prof. Herman Oberth, "Father of Astronautics," and the second to Dr. Robert H. Goodard, "Father of Rocketry," it is fitting to note that the careers of these two great scientists crossed briefly in 1921.

On learning of Dr. Goddard's report "A Method of Reaching Extreme Altitudes," Prof. Oberth, then a student of mathematics at Heidelberg, wrote to Dr. Goddard, in his limited English, as follows:

"Dear Sir:

Already many years I work at the problem to pass over the atmosphere of our earth by means of a rocket. When I was now publishing the result of my examinations and calculations, I learned by the newspaper that I am not alone in my inquiries and that you, dear Sir, have already done much important works at this sphere. In spite of my efforts, I did not succeed in getting your books about this object. Therefore, I beg you, dear Sir, to let them have me. At once after coming out of my work I will be honored to send it to you, for I think that only by common work of the scholars of all nations can be solved this great problem.

Yours very truly,
Hermann Oberth
Student Math. Heidelberg"

Huntsville, Ala.

George A. Ferrell

Thanks to reader Ferrell for bringing this interesting letter to the attention of our other readers. In May or June of 1922, Dr. Goddard sent a copy of his work to Prof. Oberth. By the time that Prof. Oberth's own work was published in Germany in 1923, Dr. Goddard had carried his experiments in liquid-fueled rockets to the point of actual testfiring. Editor.

Dear Editor,

I read your copy of SPACE Journal while making fudge. Although the fudge wasn't any good, I thoroughly enjoyed your magazine. Articles I especially liked were Dr. von Braun's "Where Are We Going?", "Father of Rocketry," "Rocket Mail," and "Reaction."

SPACE Journal has everything in it that I have always wished for but never found until now. Please continue the good work, but please don't discontinue the poetry or space fiction.

St. Louis, Mo. Donna Lucido

Dear Editor,

I have just finished reading Vol. 1, No. 2, of SPACE Journal. I especially enjoyed the article "Mars and Beyond." A number of other boys here at school are interested in space travel. We have all found your publication helpful in the classroom. I've read a number of magazines concerning space travel, but I find yours the most factual. I like the way it gives a broad view of the topic you are discussing.

I beg to differ with Joe Gibson ("Reaction," Vol. 1, No. 2). I think that the short story gives a bit of variety to the magazine and that you should continue it.

St. John's Military Academy Barry Hackner
Delafield, Wis.

Dear Editor

You would do your magazine and its readers a service if you dropped the space fiction.

William E. Dennen
Associate Editor
Children's Books
Little, Brown and Co.
Boston, Mass.

Readers Lucido, Dennen, and Hackner touch upon a point which has had the staff in grave doubts: the desirability of continuing space fiction and poetry in SPACE Journal. So far opinion has been evenly divided among the editors, but the final decision will have to come from the readers. For this reason, we are most anxious to have the reaction to space fiction and poetry from as many readers as possible. We also suggest, parenthetically, that reader Lucido read her SPACE Journal either before or after—not while—making her next batch of fudge. Editor.

Dear Editor,

My copy of SPACE Journal, Vol. 1, No. 1, second printing, has for its cover a reproduction of Chesley Bonestell's painting depicting the separation of the first stage of a four-stage spaceship. Yet the caption on the contents page reveals that a portrait of Prof. Oberth should have graced the cover. This is borne out by the photo on page 31 of issue No. 2, showing such a cover. The cover change, I assume, was due to the need for a second printing, but why didn't you change the caption? Then too, different covers for the same issue may confuse things a bit for readers who wish to collect and bind SPACE Journal. An unimportant matter, but I thought that it should be brought to your attention.

I too shared Mr. Gibson's feelings (reaction, spring issue) when I first saw your magazine on the newsstand. And I too became a convert after glancing through it. Yours is an excellent publication.

Chicago, Ill. Ken Sablik

The reprinting of the first issue was done in a hasty manner. The change in cover was done not with guile but with the advice of a large news distributor. The discrepancy which reader Sablik notes on the contents page was a blunder which resulted from the haste in getting the second printing out. Incidentally, the cover on the second printing of the first issue is a product of SPACE Journal's art staff —which is inexpressibly proud of having its efforts mistaken for that quality which space enthusiasts have come to identify as the Bonestell touch. Editor.

beyond this star

James L. Daniels, Jr.

Synopsis of Preceding Installment

The Palomar Group, a scientific organization dedicated to the survival of mankind in the universe in 1971 had succeeded in establishing an Observatory on the Moon. The Group sought then some evidence of life elsewhere in the solar system, in the hope of finding answers to the dilemma of man's eternal conflict on Earth.

The high albedo of Europa the third moon of Jupiter seemed artificial, and artifice indicates intelligent life. Brad Hudson of the Palomar Group with a two-man crew, Steve Amhearst and Myron Drake, in a magnetic drive space craft, arrived on Europa, where they found great cities surviving under gigantic glass-like domes. The human inhabitants of this hermetic world had survived a dying planet, but, in doing so, had submitted to an absolute communal government under a central body called the Primesters.

The Earthmen were held for observation by the various Socio-, Bio-, and Psycho-Physiological Councils. In Ko-Pall, the ruthless Judge Superior of the Primesters, Brad found the incarnation of Earth's own power-driven totalitarian political leaders. Ko-Pall declared the Earthmen a threat to Europa and ordered their destruction. In Mu-Bar the gentle Director of Bio-Sciences, Brad found a surviving champion of reason and hope for humankind. And in Kay-Bar, Mu-Bar's beautiful blonde daughter, Brad found the love that he had never had time for on Earth.

Mu-Bar, on pretext of scientific study, had secured permission to move Brad temporarily into his own apartment. Now a plan of escape and return to Earth for the Earthmen had been arranged by Mu-Bar.

James L. Daniels Jr., presently a publications officer in the Control Office, Army Ballistic Missile Agency, and associate editor of SPACE Journal, was born November 26, 1925, in Evergreen, Alabama. After serving as a tail gunner with the 15th Air Force during WW II, he attended the University of Alabama where he received an AB and MA in English. He has taught English in high school and in the University of Alabama extension program. His published work includes short stories and articles in fields other than space fiction. He is currently at work on a novel based on Southern politics. He is married and has two sons and a daughter.

Part II

Brad had come from the shower and stood looking through the skylight at the never ceasing eruptions on the face of Jupiter. Almost like a sun in itself; for this moon, Europa, Jupiter was the sun. Europa's whole power system was harnessed to Jupiter's miraculous high pressure hydrogen activity. So many strange reactions unknown on earth were possible under those tremendous pressures. Someday maybe an expedition could be landed there. Maybe Ko-Pall was right; perhaps Earthmen were a threat to his world. They would all think the same way about expeditions to this world. They would crawl here like maggots, over and in and around these domes.

The sharp whine of the door buzzer announced a visitor standing in range of the scanner. Brad faced the door and in a firm voice addressed the mike pickup above it, "Open."

The door slid back silently, revealing the wizened figure of Mu-Bar. Mu-Bar entered quickly and crossed the room to stand by the now neatly covered bed, which served during waking hours as a divan.

"I had almost forgotten that today was the day," Brad said.

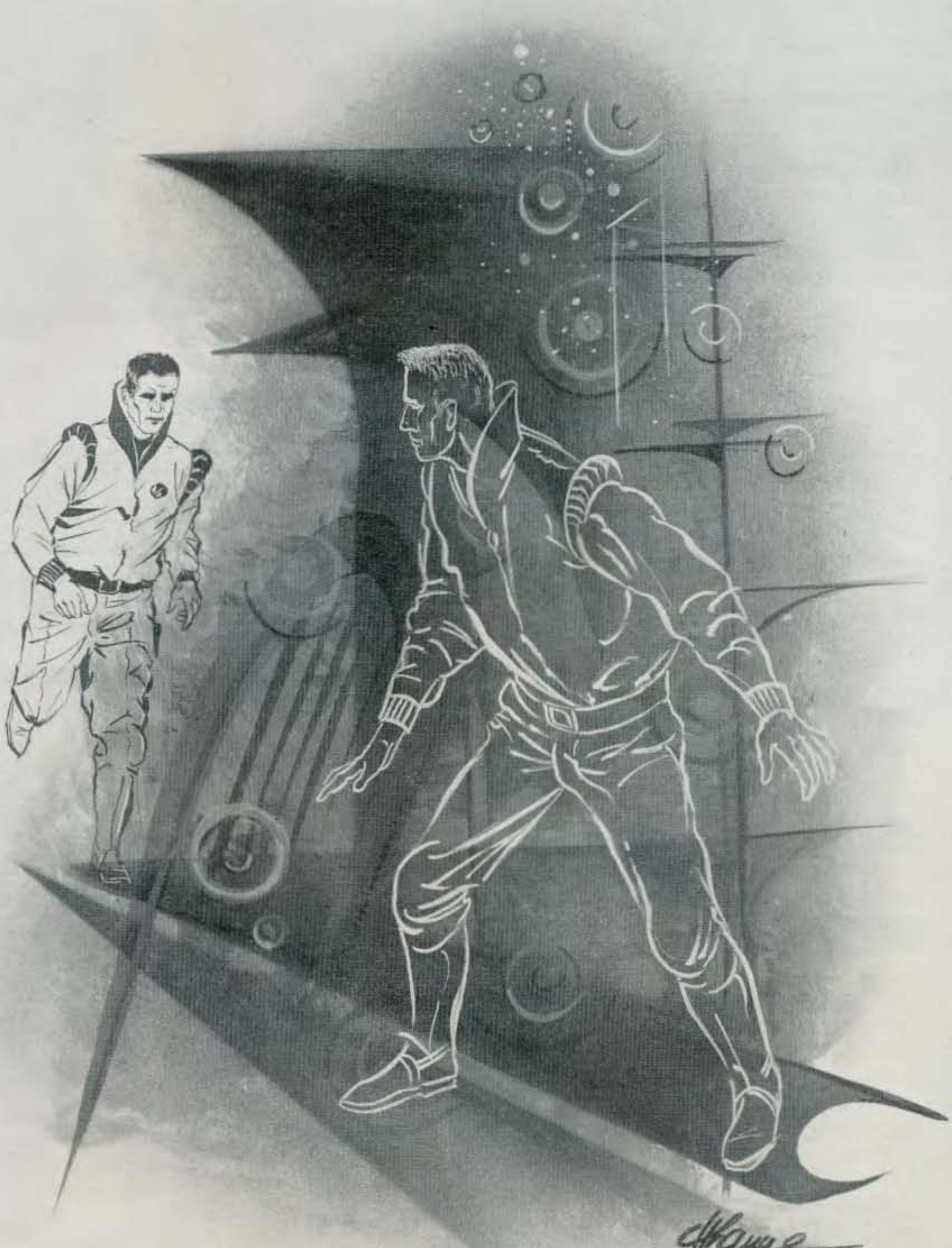
"I have arranged for your friends to be

brought to my laboratory in the Scien-Dome. The ship is there and ready. Now to the event. The car awaits in the port. You must go directly to the Primester Chambers. Remember that only with Ko-Pall as hostage can you expect to have any guarantee of safety until we can get you into space. Once out, there is of course nothing to stop you. There are no ships to pursue you."

Brad had stood facing the small man while he talked. "I've wondered about that, Mu-Bar. It's one question we haven't discussed. Why no space craft?"

"You recall that I told you of how, in the ancient times, our people crossing space stopped on the moons, and how the inhabitants of each of the moons in turn died, until only Europa was left. Here, in trying to survive, we sacrificed many things. The secret of space travel was one of these.

"Since the building of the Domes we have had neither the inclination nor the desire to travel through space," Mu-Bar told him. "We have our world recreated and livable. We survive. We need not go further. Perhaps, since surviving a dying planet and ostensibly establishing the perpetuity of our race, we have become complacent in a sort of racial security. We have accomplished the ultimate; hence, our race kultur became one of stagnation—not a dynamic thing. You see we truly did grow old as a race. Preservation of the race entailed the complete and utter submission of the part to the whole, so that the individual, as you have seen here, is nothing. The society is the organism. The entire economy, laws, technology, everything, is geared to this, to the perpetuation of the perfect balance this organism has attained, the balance that alone assures its continued existence." Mu-Bar broke off abruptly and then added "—but we have talked of this so many times, you have cited the communal half of your own world and the slow submission of your entire Earth people to its spell. And so you must get back—for the sake of the human kind you must get back and tell them—show them that that way can only be the end. Remember, Brad, if you value any thing I can tell you, that if I had the right to give a dying word, that word is 'doubt'—forever plant *doubt* in men's minds. If once they fail to doubt, they are dead—for curiosity, the fertile ultimate that will let man survive, is born only of doubt. Only through doubt can we avoid anchorage to hindsight. Doubt and you can shed old doctrines—open the mind to new, to change, to foresight. When man has all the answers he needs, when he accepts a stalemate balance—a compromise of self for existence of the social whole—then it is all over. Brad, your answers lie not in dead worlds and old people, but in the young ones and new worlds. It's up to each new generation to adapt, and to learn, and to progress—to find in the universe the expansion of the glory of creation. Each generation must expand its ability to comprehend, must go beyond the limited horizons of the generation before. If there are answers to your questions, they lie far beyond this star you call the sun and its nine insignificant worlds. Some of the answers lie in the fact that there is a beyond, a frontier yet to be explored by the young



and curious. Yes, Brad, go back to Earth and lead man out into the grand cosmos.

"But enough, the time is near. Off with you. We must have Ko-Pall in hand. You will barely have time to get him at his first session rest." Mu-Bar was propelling him with gentle pressure toward the door.

"I will have my daughter at the Scien-Dome to see you away," Mu-Bar said, and faintly smiled as Brad looked back at him in surprise.

"I know how you feel about her." They were out in the apartment corridor now near the Transi-port. Mu-Bar turned and hurried away before Brad could reply.

Left alone, Brad was conscious of the fact that he had no weapon. He remembered however, quickly, that weapons were nonexistent here, for physical threats on Europa were nothing. Sacrifice of a life was only a scratch on the hand of the social entity.

A few moments later in the Transit Tube he sped toward the terminal under the Primester Dome aboard Mu-Bar's tear-drop Transi-car on a frictionless cushion of air.

There were only ten cars in the huge terminal when he arrived, which meant only a Primester Session—no crowd of petitioners to complicate the situation. He left the car beside the one with Ko-Pall's black cross insignia on it.

Upstairs in the circular corridor Brad found Ko-Pall's cubicle. He slipped inside the dark room and waited. His breath rasped hot in his lungs. Oh, for a breath of real air. He could not remember, now, even the smells of real air, after months of breathing this stale canned stuff.

He had almost relaxed when the door suddenly swung open. A figure shadowed the slit of light across the floor. Brad tensed against the wall. The door slid shut. There was just one way—a primitive flying tackle. He crouched to spring at the shadow.

"Brad," the whisper was Kay-Bar's.

"Here," he moved to touch her.

"Quick, we have not much time. You must go. Ko-Pall knows of your plan. He has monitored your movements. He will try to stop you here. My father says to forget Ko-Pall and come directly to the Scien-Dome; he will have your friends there."

"If Ko-Pall knows, he will have them guarded."

"Only from you. He will not hinder my father. Now let's hurry."

Brad slipped into the empty corridor and started toward the terminal elevator.

"No, Brad," Kay-Bar tugged his arm and pulled him past the elevator door. "They'll be guarding the terminal." They raced on around the corridor to a smaller and unobtrusive door. It opened into a chute, slanting downward.

"Come," Kay-Bar pulled him in. A sled type transporter stood near the door. "Get on," Kay-Bar stepped onto the sled. "This sluice my father has kept in repair. Only he knows of it. It was used by the Ancients eons ago. It is primitive but my father has kept it in repair since he discovered it. He had his Scien-Dome built at the other end of it after Ko-Pall became Judge Superior. And this tunnel is shielded. The Scanners can't follow us." He sat down on the sled and gripped the handrails. Kay-Bar sent it hurtling along the tunnel.

At the Scien-Dome Mu-Bar hurried them from the closet where they stopped. "The others are here," he said. "I had to narcothize them, but they'll recover." He opened a final door to let them into a scintillating room of plastic and metallic fixtures.

Beside a long table in the center of the lab were Amhearst and Drake, sitting erect and stiff in an obvious, hypnotic state. "They'll respond to any command, Brad. You'll be able to operate the ship all right, even with them in this state. Just give them detailed instructions and they will handle their regular duties efficienctly." Mu-Bar turned to the men. "You will rise and board the ship and take your usual stations. The ship is directly across the ramp beyond that door." Mu-Bar pointed to the door across the room. The two men rose and shuffled zombie-like across the room and through the door which Kay-Bar opened for them.

Mu-Bar turned to Brad with brows knit. His shoulders slumped lower. He looked from Brad to Kay-Bar.

"You must take her with you," he said. "We are dying. Your world is young yet. We are long past our grave, a society in its senescence. We may drift on a few more of your centuries; but it must end, for we with all our science, all our eons of effort, have not found the noble answers which you came seeking. Perhaps we never started to look for them. Neither our technology nor our sociology could save us forever. The communal society, as you have seen, is not the answer for human kind; for such a society stifles the innate curiosity of the individual. We killed it here and started to die intellectually even as we learned to survive physically."

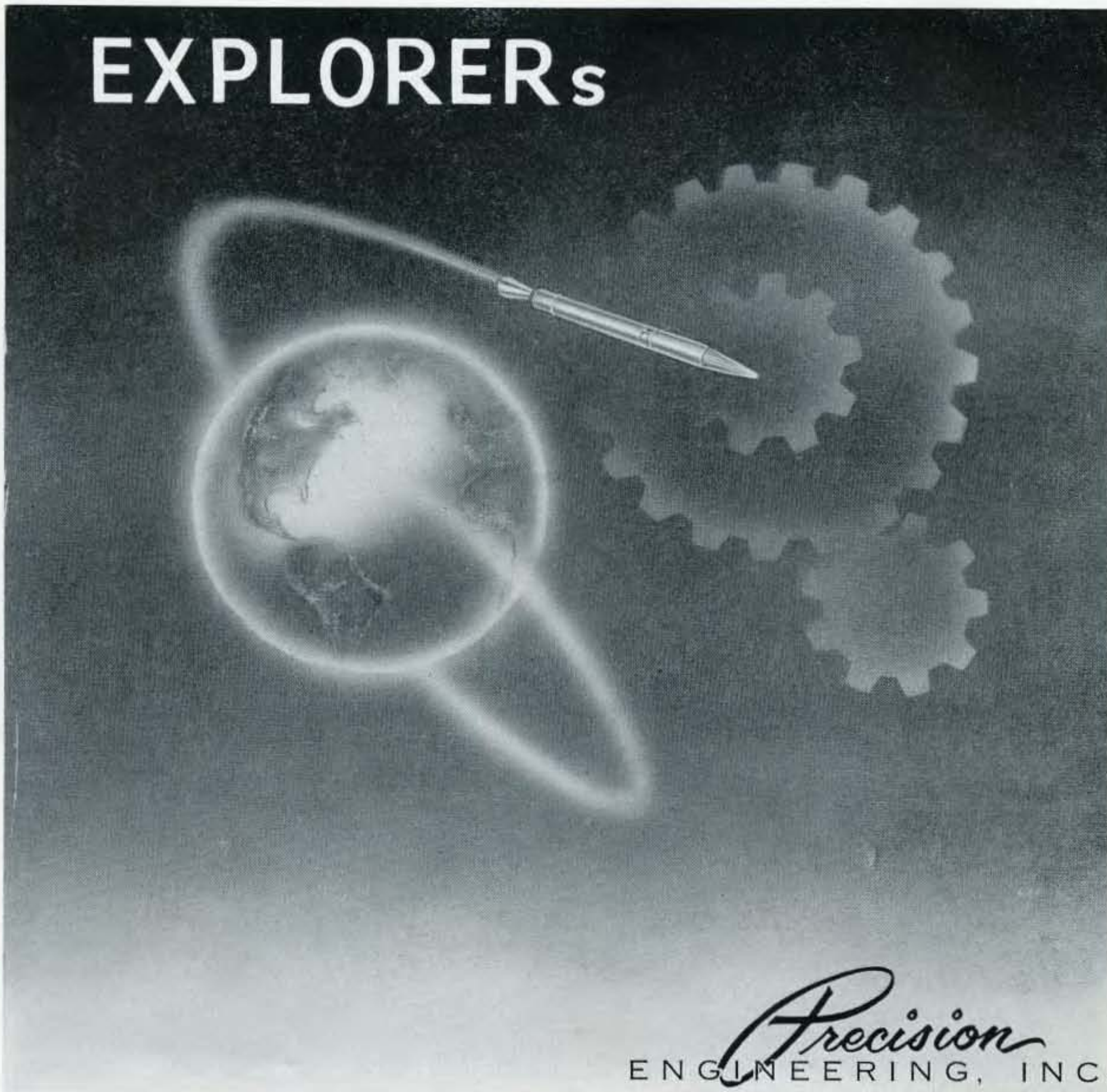
Mu-Bar moved to the door and looked after the two men who had gone out. "I am sorry that you must return to your young world without answers; yet, perhaps before you are answers better than any that you or I or anyone could formulate: one is that each world must solve its own dilemma, not borrow from others; another is that if life can exist simultaneously on the same form as ours in two places in our own system, then there must be millions of other worlds where life exists in this eternal universe. A never ending frontier! Conflict itself perhaps cannot be eliminated, but the energies which would be exerted in struggle can be channeled into curious sniffing about, as long as there is a frontier to sniff in. Find ways to probe it, Earthman, and your Earthkind will live. Do not build up walls around you and try to outlive your own world. Find new ones. Since you have started as young as your world is and have made such progress, there is no reason why you cannot continue to reach out and out into this infinite universe."

"And you, Mu-Bar, you will come with us, too," Brad urged.

"No, I must stay. It is too late for us—for me. I am of this world. My daughter is young enough not to have absorbed this world's culture. As I have told you since her conception, I have guarded her from it. She is, as you have said, like an Earthwoman. Besides, I shall die happy, knowing that this world survives in yours—that the old is part of the new, that your mating represents the survival of our world after all, since truly your progeny will be sons of this world, too. Now it is time to go." Mu-Bar rushed them toward the door.

From the starboard port Brad, with Kay-Bar's quiet tears hurting as his own and with his arms around her, watched the tiny figure of Mu-Bar standing inside the Dome while the portable launch ramp Mu-Bar had constructed wheeled their ship into position outside.

The ship silently spiraled up. The crushing acceleration began. Brad turned with Kay-Bar to the forward port and looked long across the darkness at the tiny point of pale blue light—Earth.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Dr. H. W. Ritchey

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