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SR / Research

SCIENCE & HUMANITY



DEPARTMENTS: Research in America • Research Frontier • Letters

RESEARCH IN AMERICA

THE ROBOT ON THE MOON

A FUNNY thing happened to Luna 9's TV pictures on their way back from the moon.

These photographs were the first ever taken on the moon's surface, and Luna 9, a robot made in Russia, sent them home to earth in answer to a radioed order from the Russian steppes.

Waiting to catch them, on the night of Thursday, February 3, 1966, was a battery of eight small radio telescopes in the Crimea. Through broken clouds the full moon shone almost straight down on those upturned saucers as clocks in Moscow were just about to strike ten.

Over the horizon, hundreds of miles and three hours of sun time off to the west, a far vaster listening dish—250 feet across—stood cocked at a sharp angle across the meadows of Jodrell Bank, near Manchester, in England. This giant radio telescope, too, stared at the moon, which had not yet risen very far into the sky over Britain.

Sir Bernard Lovell, the noted astronomer in charge of this world-famous instrument of interplanetary space exploration, had been tracking the moon-bound ship on which Luna 9 had been riding since the day after the voyage began on January 31. He knew the correct wave length of the electromagnetic spectrum to tune to because the Russians had made this same trip at least four and perhaps six times before, each time using the identical communications channel: 183.538 megacycles.

It was only late afternoon of February 3 at Jodrell Bank when the tracking chore for that day began. The sun was still well up, dominating a clear-skied day, as the incoming messages revealed the moonship steadily accelerating under the pull of lunar gravity. The Tass correspondent in London had misunderstood the advice he got from his home office in Moscow and had told Sir Bernard there was no particular urgency

about setting up a watch for the night. The landing, the correspondent said, would not be due until London's Big Ben boomed ten.

According to that timetable, something must be out of joint in the neighborhood of the moon. The moonship slowed its pace abruptly long before the brakes should have gone on for a 10 o'clock UT (Universal, or Greenwich meridian, time) arrival. Through the electrical nerves of his big dish, Sir Bernard could almost feel the retrorockets firing. The dusk was holding the night at bay, at 6:45 P.M. UT, when the incoming chatter suddenly died. The moonship had hit the moon.

For almost five minutes after that, the Jodrell Bank telescope heard nothing further. Then Luna 9 itself, the automatic moon observatory that had ridden the Russian moonship's nose, began to report what it felt and saw.

All these happenings were recorded on magnetic tape, in the same cautious scientific tradition that keeps photographic plates continually capturing records of events in the sky as seen through the eyepieces of optical telescopes.

AT first the messages sounded like one of the simpler codes in which facts are transmitted in the form of binary numbers (zeros and ones—sounds and silences) over long-distance telemetry. But after ten minutes the signal pattern changed remarkably in character.

"Don't you recognize that, Sir Bernard?" asked his Jodrell Bank colleague, Professor John G. Davies. "It's the same as the one we got off the Echo 2!"

The Echo 2 balloon experiment had been an international one in which TV pictures were shuttled across the heavens and under the sea from Telstar to America to Jodrell Bank to Russia. Done in 1964, the work remained memorable because the facsimile photographs in-

volved were of a standard format, in which one pencil-thin line of alternating light and shade was laid down every second until a thousand lines fit side-by-side into a black and white rectangular image measuring eleven by ten inches.

All British newspapers big enough to feature pictures to any appreciable extent have in their engraving shops machines capable of recording photographs in this standard pattern from electrical signals transmitted over telephone or telegraph wires. Aware of this situation, Sir Bernard asked the newsmen assembled at Jodrell Bank that day (they had come to hear whatever news the radio telescope might bring from Luna 9) if any of them would care to join in a popular science experiment. Could any one of them persuade the paper he worked for to lend Jodrell Bank a facsimile picture receiver?

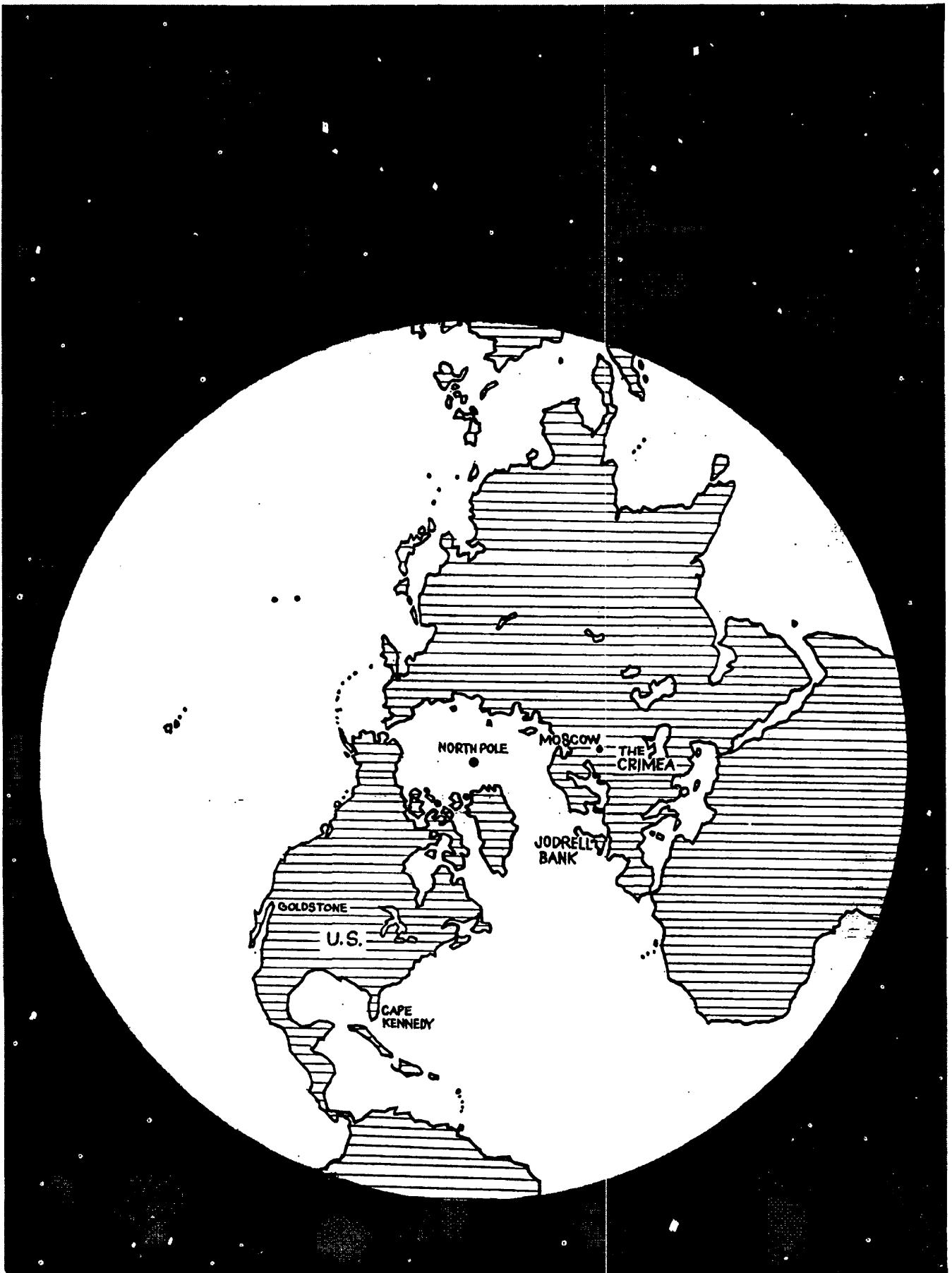
The man from London's *Daily Express* volunteered to try.

BACK in Moscow that night, Tass waited an hour after the Luna 9 landing and then broadcast an official announcement of the exploit:

Moscow speaking. Here is a Tass announcement:

An outstanding achievement of science and technology: At 21:45 Luna 9 achieved a soft landing in the Ocean of Storms. A communication link has been established with the earth.

That some of the communications might consist of photographs was not disclosed to the Russian people either in the radio reports they heard that night or in the newspapers they read on the following morning. It was simply stated that scientific instruments aboard Luna 9 were functioning and that their readings were being transmitted to earth on a wave length of 183.538 megacycles. Luna 9's position on the moon was given



—Doug Anderson in consultation with Dr. K. L. Franklin, Hayden Planetarium-American Museum Natural History.

How earth was lighted by full moon (opposite page) at time of Luna 9 landing. Note zenith over Persian Gulf. Any point within golden cap could receive TV pictures by line-of-sight.

only roughly: west of the lunar craters Reiner and Marius.

In New York City, however, Thursday afternoon's radio news broadcasts and early-evening editions of the newspapers (the Luna 9 landing occurred at 1:45 P.M., Eastern Standard Time) were already adding mention of the picture-signal pattern received at Jodrell Bank to the bare facts issued in Moscow.

By the time the earth turned England into the dawn of Friday, February 4, the *Daily Express* man assigned to Jodrell Bank had persuaded his editors to lend Sir Bernard Lovell a standard wirephoto receiver. By the time the moon rose over the Jodrell Bank horizon again, the machine was already hitched to Sir Bernard's radio telescope.

THERE is a deceptively sleepy look on Sir Bernard's face much of the time. It may have misled the reporters around him to suppose that he was utterly confident of the results of his experiment with the borrowed picture receiver. He went about his usual business in the laboratory apparently unconcerned with the technicians who were struggling to adjust the machine, and they finally had to summon him from the lab to see the photos that emerged.

Later he told SR's science editor on the transatlantic telephone that this whole episode had been misinterpreted. Actually, he said, he had been "surprised to find that the pictures of the lunar surface came out of the machine" and "amazed by their quality and definition."

On the science editor's invitation, Sir Bernard subsequently cabled a complete account, exclusively for SR's readers, of how photos taken by a Russian robot on the moon were first published here on earth through the intervention of a radio telescope in the British Isles.

Sir Bernard's report is reproduced verbatim on pages 60 and 61. Perhaps out of modesty, it neglects to mention the uncanny skill with which seasoned astronomers can sometimes infer information from pictures of distant and hostile worlds. Although the first of the Luna 9 photos released by Jodrell Bank was long and skinny when it should have been short and fat, the essential features of the landing area were all accurately captured, and the horizon was shown to lie to the side rather than above the robot photographer. Sir Bernard correctly deduced from this one image that Luna 9 landed askew.

To avoid repetition, I shall refer my readers to Sir Bernard's account, taking space here only for a few pertinent points that he clarified in our telephone talk.

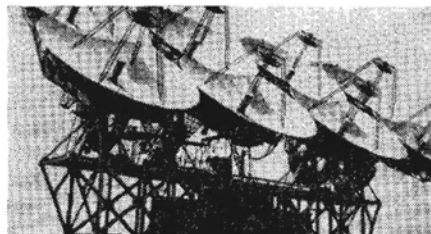
As he suggests in his own text, with justifiable pride, Professor Lovell is widely known and respected among astronomers for his efforts to bring about

cooperation between Communist and non-Communist nations through the agency of his radio telescope. He had much more to lose than to gain by risking offense to the Russians. He kept in touch with the Tass correspondent in London to try to assure himself of certain knowledge of Moscow's intentions. The Tass correspondent knew that space was being held open in the pages of *Izvestia's* Saturday morning edition for illustrations of the Luna 9 voyage. He assumed, as any alert newsman would, that the illustrations would be the Crimean prints of the moon pictures received by TV at Jodrell Bank. He was probably even more surprised than Sir Bernard was to discover that the waiting hole in *Izvestia's* columns was finally filled with unexciting propagandistic photos of the flags that the moonship carried along with Luna 9.

Sir Bernard's cautionary measures had not stopped with the Tass correspondent in London. They were extended to include direct TV observance of happenings in Moscow. There a press conference on Luna 9's voyage was televised to the Russian people on Friday. The Eurovision network carried the broadcast onto the continent and thus to Jodrell Bank. This press conference took place several hours before Sir Bernard gave his set of Luna 9's moon pictures to British newspaper and international wire service reporters. Everything he saw on the Moscow TV screen seemed to be leading up to a public interpretation of the pictures. When the Eurovision link was suddenly and irreparably broken, he saw no reason not to assume that the remainder of the press conference would follow the logical thread of the part he had witnessed and would conclude with a showing of the illustrations *Izvestia's* editors were waiting for.

WHAT it was that knocked Eurovision off the Moscow TV circuit at a crucial moment in history is still as mysterious to Sir Bernard as why it was that the Luna 9 press conference in Moscow didn't end with a dramatic display of Luna 9's moon photos.

Even more curious to me than either of those questions is why the Russians designed Luna 9 to send its pictures in



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Crimean battery of small radio telescopes, not far off lunar zenith point (above) and (right) Jodrell Bank receiving dish.



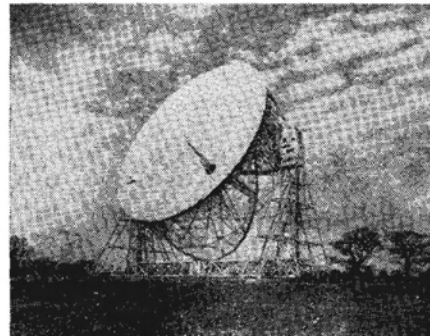
a simple pattern that almost any open-minded radio astronomer anywhere would recognize and easily copy. I asked Sir Bernard's opinion on this point.

"It's a very nice question," he replied. "A very nice question."

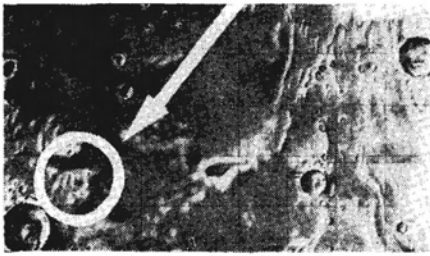
A possibly significant sidelight on the situation can be seen in the nature and extent of Russian criticism of Sir Bernard for making the Jodrell Bank pictures available to the other peoples of earth before the pictures were published in the Union of Soviet Socialist Republics. Only one man has spoken out—a prominent scientist. He is Dr. Anatoly A. Blagonravov, chairman of the Soviet Commission for Exploration and Use of Outer Space, and his remarks have been directed to the difference in picture scaling already referred to here. The width of the Jodrell Bank reproductions had been compressed two and a half times, giving projections above the lunar surface a sharply jagged relief.

Sir Bernard first should have got "the information necessary for correct reproduction of the image," Dr. Blagonravov said. "Apparently some motives of a sensational nature played a role in this case. The most important thing in the interests of science is the trustworthiness of facts; the Soviet scientists were guided precisely by these considerations in carrying out such exceptionally important and responsible experiments."

This was a mild rebuke indeed. I remarked on the mildness of it to Sir Bernard on the telephone. I asked him whether he didn't think that if the Rus-



—Wide World.



—Sovfoto.

Luna 9 landed near moon's equator not long after lunar sunrise.

sians really disapproved they would have raised a fierce chorus of protest.

"I am sure the Russians don't object to what we did," Sir Bernard replied. "I am sure they intended us to do the recordings. If they hadn't wanted us to receive the pictures, all they had to do was to command the Lunik one hour earlier than they did, and we would not have got the pictures. We can't receive anything from the moon before the moon rises above our horizon."

If the Russians were annoyed at all, the resentment didn't prevent them from working closely with Sir Bernard on another scientific experiment several days after the Luna 9 excitement subsided. Moscow bounced radar signals off planet Venus to the Jodrell Bank telescope, and Jodrell Bank bounced similar signals off Venus to Moscow.

FROM these and all the other facts that I have been able to gather about this affair, I am convinced that up to now the story of Luna 9 has been told from the wrong perspective. I think the true meaning of one of the most important events of the twentieth century has been missed. To me, it seems plain that the Russians not only wanted Sir Bernard Lovell to receive the pictures taken by their robot on the moon but actually waited for him to publish the pictures first. I can conceive of at least two excellent reasons why the Russians should have preferred such a course.

To begin with, Luna 9's pictures are a far more stunning technological brilliancy than anyone in Washington has publicly admitted. They belong in a totally different class from anything the Russians (or any other people) have done before. The two greatest Soviet spectacles of the recent past—the orbiting of Sputnik 1 in 1957 and the first crash-landing on the moon in 1959—could be attributed, in company with many lesser feats, principally to the fortuitous construction of huge and powerful rockets to carry the earliest and crudest H-bombs. But the soft landing of Luna 9 entailed something much beyond brute power, considerably outside any dimensions of size. Built into Luna 9 was a subtle sophistication in cybernetic guidance that no one else on earth has yet demonstrated. These delicate

precisions were successfully conveyed over a distance of thousands of miles.

Putting a spaceship into orbit around the earth, rocketing it out of orbit at the most favorable juncture for a chosen destination, turning the ship around in mid-voyage, shifting the angle of its course of travel—all these maneuvers have become commonplace. And all of them were performed at critical points in the voyage of Luna 9. What Luna 9 did after completing them (see sketches, page 63) was to respond to the radar feedback of an automatic altimeter just seventy-five kilometers (46.6 miles) off the moon's surface and throttle down in

forty-eight seconds of time from a cruising speed of 5,600 miles per hour to a near-hovering fall of under ten miles per hour.

The response actually occurred at a height less than 10 per cent (3.4 miles) lower than the height assigned to the robot in advance, Sir Bernard disclosed in a scientific report published in the February 26 issue of the British journal *Nature*. The landing speed could not be determined with comparable precision from the Jodrell Bank readings, but Sir Bernard said it was "very low."

During those last three-quarters of a minute of the voyage, what the Russians

Sir Bernard Lovell's Exclusive Cabled Report

JODRELL BANK, ENGLAND.

LUNA 9 landed on the moon at 18:45 UT on February 3, 1966. The deceleration accompanying the firing of the retrorockets and details of the landing phase were perfectly recorded by the large radio telescope at Jodrell Bank. After a few minutes' silence Luna 9 began transmitting, and we realized that the Russians had succeeded in carrying out the immensely difficult task of landing working scientific instruments on the surface of the moon.

Ten minutes later, the telemetry signal changed in character. My colleague, Professor John G. Davies, asked me if I did not recognize the signal. It was precisely the same in character as we had transmitted to the Russians via the Echo 2 balloon in the American-British-Russian experiment in the spring of 1964. It was indeed a facsimile picture transmission in standard form, with an approximately one-second line scan.

We had no suitable equipment at Jodrell Bank with which to reproduce this picture. I told members of the assembled press that we believed Luna 9 was transmitting television pictures from the moon and asked if any of the reporters present could obtain a standard picture recorder of the type which must exist in every newspaper office. One British newspaper responded with alacrity, and shortly after moonrise the next day (February 4) Luna 9 again began transmitting facsimile picture signals. We fed these directly into the recorder.

It must be admitted that we were surprised to find that pictures of the lunar surface came out of the machine. We were amazed by their quality and definition.

By this time the entrance hall and corridor of the [radio telescope] control building were crowded with pressmen and photographers. After a few minutes of processing, I held up the first picture to be photographed and made a few

brief comments. It is this photograph which appeared in the newspapers on the morning of February 5. To my amazement, I later learned that the Russians had still not produced the photographs for reproduction inside Russia.

A few days later, a storm of criticism descended on me. Some quarters accused me of unethical behavior in releasing these photographs. One Canadian colleague even went so far as to say, in a public lecture, that what I had done was equivalent to my publishing someone else's scientific paper which had been sent to me to referee.

My colleagues and I are hurt and amazed by these reactions, which we consider to be based on a lack of appreciation of the details of the situation. My refutation of the charges is based on the following facts:

1. No photographs were released until nearly twenty-four hours after Luna 9 landed and began its television transmission.

2. Several hours before I released the first photograph, a press conference was held in Moscow. We watched this conference on a TV screen at Jodrell Bank until the Eurovision link was lost. It seemed to be the general assumption that the first photographs were to be shown at that conference, and we were told that space was reserved in *Izvestia* for their immediate publication. The suggestion that we were intentionally scooping the pictures is therefore absurd.

3. Our reception of the Luna 9 signals and photographs owed absolutely nothing to any information given us by the Russians. Some of our critics have made much of the fact that the Russians announced the frequency of the transmissions. This announcement was quite irrelevant. The frequency was the same as that used on every Lunik since 1959. In any case, the Tass announcement was

have since described only as a "shock-absorber system" was somehow activated (perhaps by a closely timed explosive charge, or by a powerful spring latch released by a clock), and a ball two feet in diameter was tossed away from the landing rocket onto the moon's surface. Like a seedpod wafted on a breeze, the ball fell and split open; four petals folded outward and down, releasing as many pistil-like antennae which may have been coated with mirror-bright surfacing on two sides to reflect the lunar landscape into the TV camera lens.

The ball may have been thrown into the air and allowed to drift down (the

pull of lunar gravity being only a sixth as strong as the pull of gravity on earth) or it may have been ejected with a side-wise thrust to cause the ball to skip lightly across the moon as flat stones can be skipped across the surface of a pond. Either way, the big trick obviously was to get rid of the destructive force of the rocket's falling weight (3,482 pounds: roughly a ton and a half), and this was accomplished by separating the ball from the rocket and letting the rocket crash alone, thereby dissipating most of the energy. Still more energy may have been removed by the crumpling of a protective shell around the ball. The first of

the American moon rangers were designed on such a principle; each of them carried a roly-poly seismograph to be ejected onto the moon in a collapsible hull of balsa wood. Unfortunately, none of the roly-polys ever got near the moon.

However the job was done, the Russians did it with Luna 9. To have a renowned non-Communist scientist as the confirmatory agent of such an historic leap in the techniques of exploration guaranteed immediate acceptance of Luna 9's message everywhere.

Coming by so circuitous and unexpected a route, the news of Russian dominance in an area of super-technol-

on the Luna 9 Pictures Received at Jodrell Bank

made after the reception of the facsimile transmissions at Jodrell Bank.

4. The argument that we published a scientific analysis of the photographs before the Russians published is nonsense. I particularly emphasized to the press that the only information we had about the scale was the appearance, in the foreground of the pictures, of a part of the Lunik. The broad limits which I suggested for the scale turned out to be reasonable (our pictures should have been expanded in the horizontal direction by 2.5 times).

The only scientific comment I made was that there did not seem to be any thick dust and that the Lunik was obviously resting on a hard surface. Both these comments had been made hours previously by scientists at the press conference in Moscow.

5. We are publishing our results (the details of the landing phase and the technique of producing the photographs,

with examples, but *not* any attempt at a scientific analysis of the photographs) in *Nature* in the usual manner of scientific publications. These data have been obtained by the free use of our instruments in the same way that data for dozens of scientific papers have been obtained by observers recording the beacon and telemetry signals of other peoples' [earth] satellites.

6. The Russians are fully acquainted with the details of our facility. They have used it themselves in the past to search for one of their planetary probes. If they did not wish us to receive the signals, they were aware of a number of easy courses of action which would have enabled them to make it impossible for us to do so.

7. Jodrell Bank is a department of the University of Manchester. Freedom in the publication of scientific data is a guiding principle of the university. Unless previous collaborate arrangements

have been made, I would consider it unethical and a breach of fundamental principles to withhold information obtained by our instruments whenever it is of scientific or public interest.

The unexpected delay in the release of the photographs by the Russians has turned out to be unfortunate insofar as it has led some people to accuse us of engaging in unscientific and unscrupulous behavior. I doubt if any observatory has struggled harder and more successfully for close cooperation with Russian scientists. It would, of course, be a great misfortune for us if the Russian Academy really was offended by this episode. There is no sign that they are. All the criticism has come from the North American continent (apart, that is, from Academician [Anatoly] Blagonravov's comment, which is understandable under the circumstances).

We have two current astronomical programs which are being carried out in cooperation with our Russian colleagues. One is the bistatic Venus experiment, the other the joint optical-radio flare star study. Both of these have continued without hindrance since the affair of Luna 9.

One thing is quite clear. Whatever action I had taken on the afternoon of February 4 would have been criticized by someone. Two other courses were open to me. I could have withheld the photographs from the press. I suspect that had I done that I would have been stormed with accusations of Communist sympathies and of withholding valuable information from the Free World. Or I could have stopped observing and gone home. I would then have been held guilty of professional incompetence.

Perhaps even the Russians, to whom we gladly supply copies of our tapes on these occasions, would have been offended at our inactivity and disregard of their immense achievement.

—SIR BERNARD LOVELL.



—Wide World.

Sir Bernard Lovell interpreting a TV photo received from Luna 9.

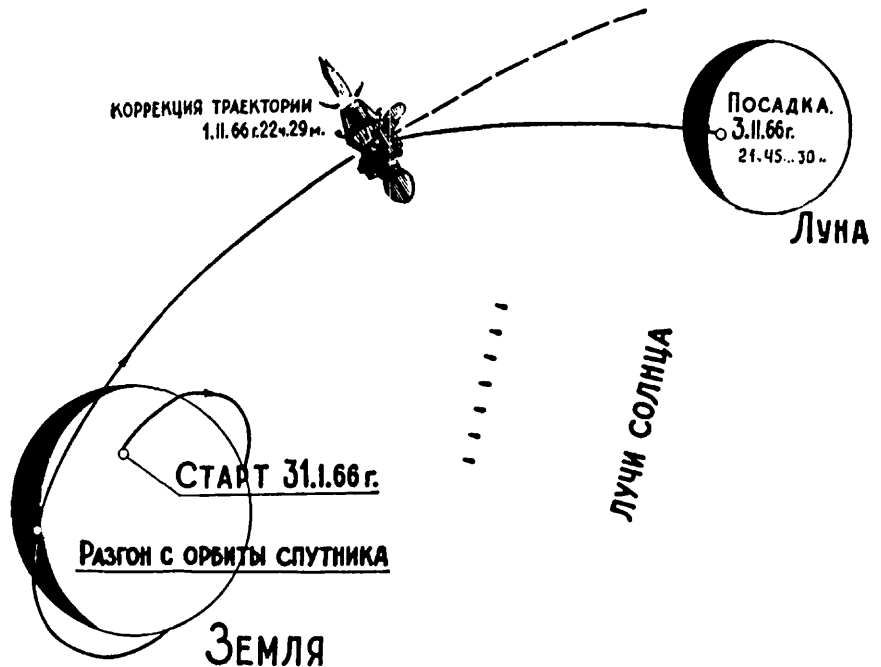
ogy where the Americans continually boast of supremacy would strike with doubled impact in the minds of Vietnamese and others who must choose between the power of Moscow and the power of Peking.

Sir Bernard Lovell would be an almost unique vehicle for a genuine attempt at international cooperation in moon exploration. He had argued consistently over many years for better understanding between east and west. If the White House and the State Department have the will to see his role in the Luna 9 affair from that perspective, and to respond with the wit the late President John F. Kennedy employed in answering a seemingly rambling letter from former Soviet Premier Nikita Khrushchev at the climax of the missile crisis in Cuba, the publication of the Luna 9 pictures by Jodrell Bank may in time rank with the Antarctica Treaty as a quiet milestone on the road to peace.

It is curious that these strategic and diplomatic aspects of Luna 9's voyage should be so universally obscured, for they have certainly not been overshadowed by major scientific discoveries reported by Luna 9. The nature of the surface of the moon is as debatable today as it was before Luna 9's carrier rocket took off. Only lamentably poor newspaper, radio, and TV coverage of the voyage has made it seem otherwise.

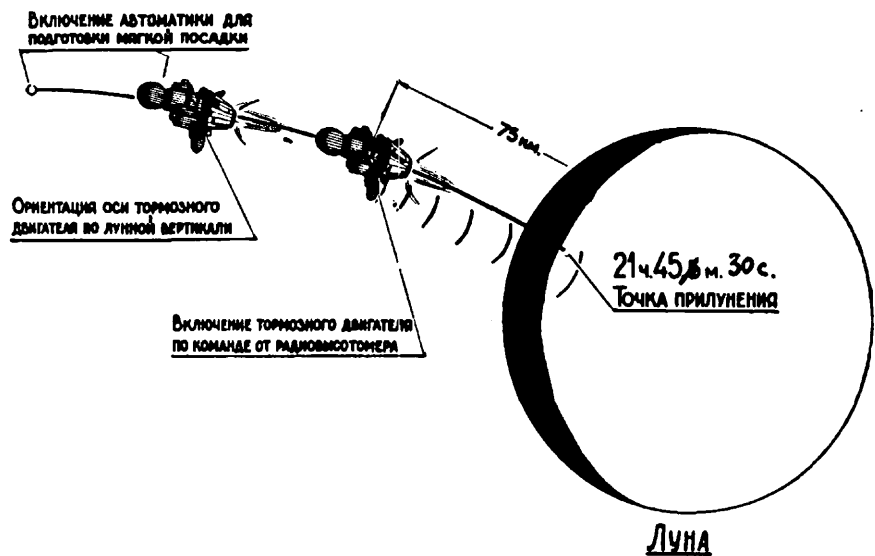
When Moscow first announced that Luna 9 had landed on the moon with instruments intact enough to broadcast information, almost all the science writers in the United States jumped to the conclusion that a manned landing had been assured. This gross misinterpretation arose from the supposition that the entire rocket body, which weighed a ton and a half, had touched down softly and survived. The Russians never made any such claim. They said very soon after the Luna 9 landing that the little robot observatory had "detached itself just before touching down and landed at a distance from the rocket installation." Crashing of the rocket, though not deliberately stated, was clearly implied, and unidentified metal fragments (one shaped like a twisted spoon) lying within range of Luna 9's TV cameras heightened this impression. Days passed before any reporter thought to ask how heavy was Luna 9. The weight turned out to be only 220 pounds. And even that small burden was distributed over a spherical surface about two feet in diameter. That the moon's crust would support 220 pounds without evidence of strain did not, however, mean that a 220-pound man could walk across the moon without sinking into the crust. For a man's whole weight falls on two relatively small feet, which would tend to plunge like pistons. Furthermore, a lunar landing would not

FROM MOSCOW: A ROUGHLY SKETCHED STORY OF THE LUNA 9 VOYAGE

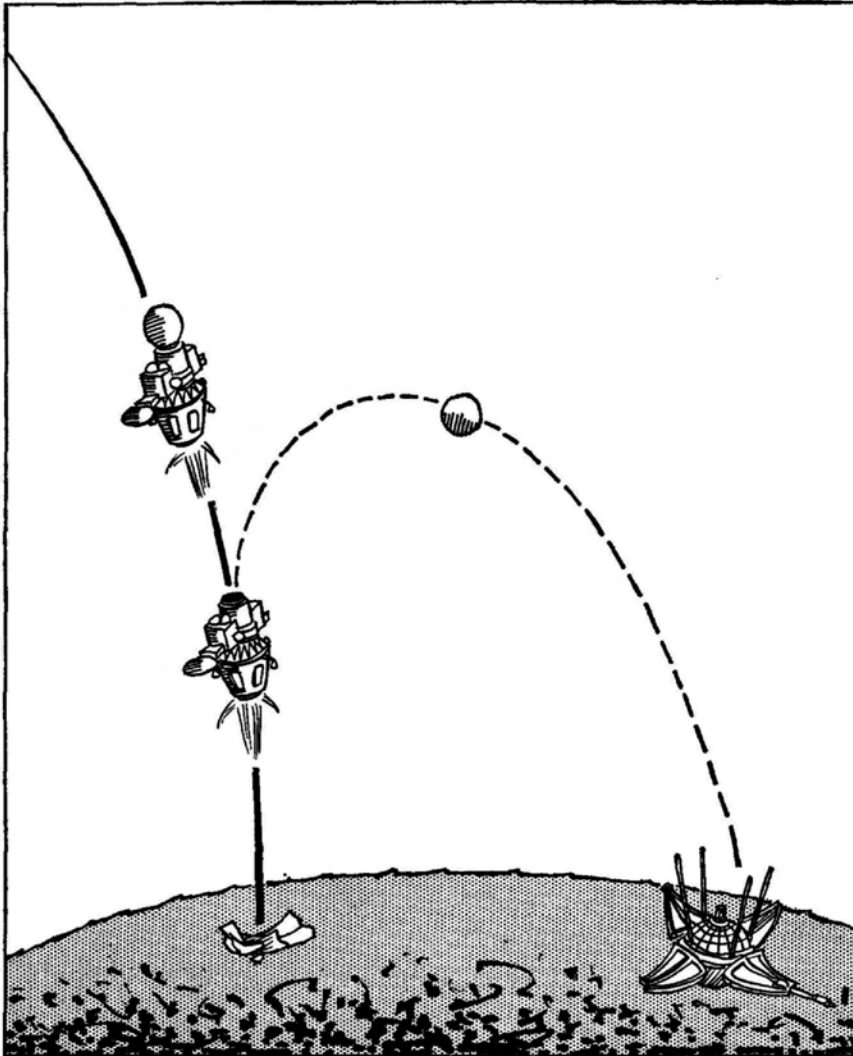


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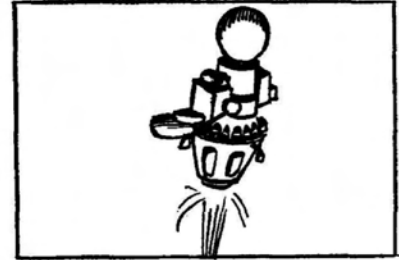
Luna 9's rocketship (above) in mid-voyage course correction. Earth orbit at left, moon target at right, direction of sun's rays indicated by arrows in center. Rocketship's approach to the moon (below) includes automatic radar altimeter primed to start variable thrust retrorocket firing 75 kilometers off the moon.



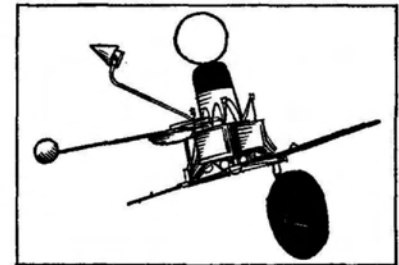
—Sovfoto sketch retouched by Doug Anderson.



—Doug Anderson.

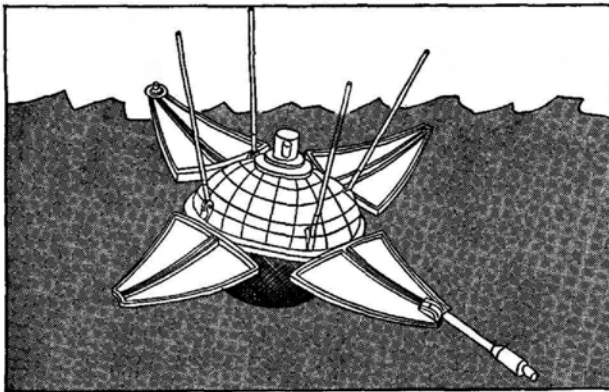


—Doug Anderson after Sovfoto.

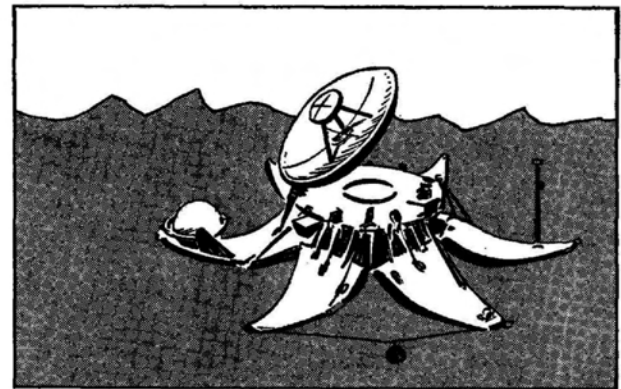


—Doug Anderson after NASA.

Ball containing Russian robot moon observatory Luna 9 is speculatively sketched at left in one of several possible ejection phases of rocket landing on the moon. Sketch at top above is copied from Russian artist's illustrations (opposite page) distributed by Sovfoto. Sketch immediately above is taken from a U.S. National Aeronautics and Space Administration drawing, and shows a similar ball that carried a seismograph on the first American moon rangers, all of which widely missed the moon.

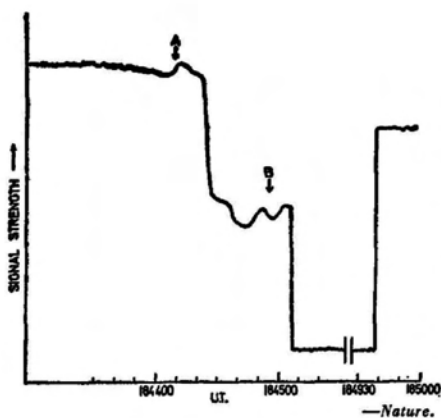


—Doug Anderson after Sovfoto.



—Doug Anderson after NASA.

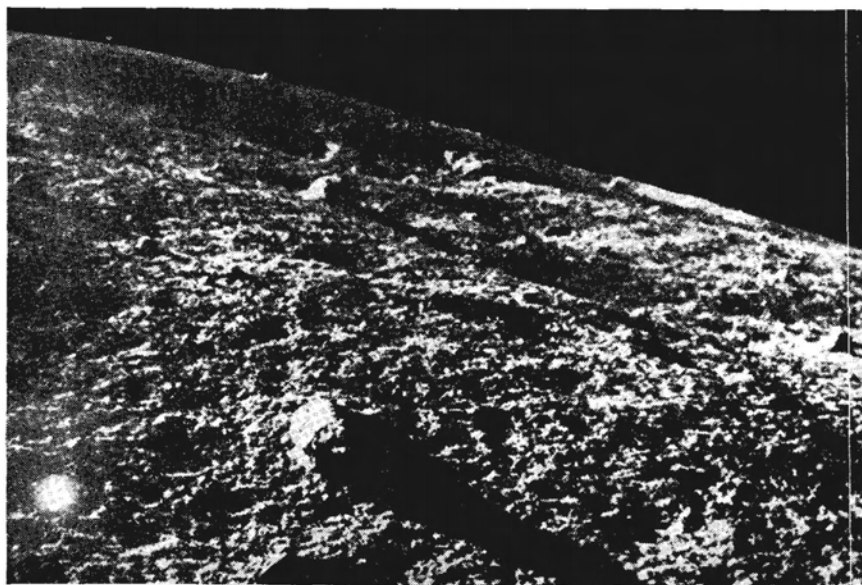
In landing on the moon, Luna 9 opened like a flower (immediately above, left) with petals reaching outward and down to free four pistil-like projections, assumed to be the broadcasting antennae of the robot observatory. TV photos of the moon sent back to earth by Luna 9 show upright strips of mirror reflecting the lunar surface. These two-sided mirrors may have been on the inner edges of the four pistils and focused on the TV camera presumably contained within the small cylinder rising from the center of the top of the ball. The more elaborate flower-like device sketched here (immediately above, right) is a NASA conception of the American interplanetary space Voyager, designed for visits to Mars. Is the Russian sketch of Luna 9 telling us that there is a simpler and equally effective way of putting space-exploring robots together? The message is cryptic. Much more explicit are the Moscow captioned drawings on the opposite page, which give the starting, course-correction, and landing days and hours of Luna 9 as well as the working range (75 kilometers, noted in the lower drawing) of Luna 9's automatic radar moon-brake.



THE LUNA 9 LANDING, as seen by the Jodrell Bank radio telescope, is shown in the graph above. Deceleration began at point "A" and ceased at point "B." Vertically walled canyon denotes silence until Luna 9 spoke from the moon. Photo immediately below is horizontally compressed print processed at Jodrell Bank. Note how shadows lengthen and surface elevations flatten in Crimean print of same picture at bottom of this column.



—Wide World.



—Sovfoto.

be made by individual men but by men riding a ferryboat from a moon-orbiting spaceship. The downward blast of the ferryboat's braking rockets would loose at least 100 times the thrust of the moonship that carried Luna 9. Perspective on future lunar exploration will be saner if it is remembered that the scientists in Moscow said only that the Luna 9 landing proved the capability of the moon's surface to support "more or less heavy objects," which is just about as elastic a description as can readily be devised.

Sir Bernard Lovell's mistaken scaling of the pictures received at Jodrell Bank from Luna 9 compounded the misleading effect of the uncritical American reporting attitude. By unwittingly shrinking the width of the TV images of the moon, Sir Bernard portrayed a jagged-looking landscape that resembled quickly cooled lava to those scientists who think great stretches of the moon are covered with very hard lava rock. Immediately there arose a clamor that the moon's surface was solid. The clamorers unfortunately forgot that infrared and radar scanings of the moon do not support the idea that lava is present. Indeed, there is no known rock on the earth's face that has the same reflecting qualities as whatever the moon's surface is made of.

Dry rock dust (Portland cement powder, for example) is accepted by most astronomers as the substance that comes closest to approximating the response of the moon's surface to the infrared and radar probing. That is to say, a layer of such dust alone exhibits the extremely efficient insulating characteristics displayed by the moon. The lunar day lasts two weeks, the lunar night an equal length of time. Between lunar noon and lunar midnight, the surface temperature on the moon swings over a range of 500 degrees. But only a fraction of an inch under the surface of the moon, infrared

and radar investigations find very little temperature change. Whatever stuff the surface is made of shields the regions below from extremes of heat and cold.

It was because of the repeated infrared and radar observations of the moon through optical and radio telescopes in recent decades that existence of a dust layer on the moon originally came to be postulated. Luna 9 reported nothing that would explain these observations. If a dust layer does not account for the temperature insulation, what does? Lava doesn't. At least the types of lava that have been found on earth do not.

PROFESSOR Thomas Gold, British-born cosmologist now on the faculty of Cornell University, is one of the leading advocates of the dust layer theory. He was not surprised by the TV pictures sent back from the moon by Luna 9. Work done in his laboratory and described in the scientific literature by Dr. Bruce Hapke months ago anticipated that the lunar surface would look very rough when viewed close-up (Luna 9's TV camera saw it from no greater a height than two feet and perhaps even lower down) and very smooth when seen from a distance, as the moon is seen in optical telescopes. As soon as the Luna 9 pictures were published in this country, Professor Gold got a small box and poured loose cement powder over the bottom of it. Then he took handfuls of cement powder from a bag and threw it at the cement he had put on the bottom of the box. Pictures of the bottom of the box after that looked very much like the pitted and pocked moon surface shown in the Luna 9 photos.

Next Professor Gold rolled rock powder loosely in his hands and tossed it into the box. Pictures of these loosely compacted balls cast shadows remarkably similar to the shadows thrown in the Luna 9 pictures by what the Russians speculated were lunar rocks six inches in diameter. Professor Gold pointed out in a Cornell campus interview with SR's science editor that because the weight of lunar gravity is one-sixth the weight of earth's gravity, it would be possible for dust balls to form on the moon up to a size of eighteen inches without collapsing. While discussing this point, the Cornell professor drew from his library shelves a U.S. Army photograph of a rocket crater in the sand of a southwestern desert. Around the rim of the crater lay chunks of displaced earth a foot or two across. The text of a scientific paper in which this illustration appeared said the earthen chunks actually were dust too lightly compressed to be picked up; when lifted, the chunks crumbled.

Luna 9's TV camera had snapped several sets of pictures of the same backyard-sized area of the moon at different

times. Comparison of the prints reveals a minor shift in Luna 9's position during the picture-taking period. Supporters of the lava-surfaced-moon concept suggested that a moonquake had moved the Russian robot observatory. Professor Gold said a severe shaking of a solid surface would have been required to achieve such an effect, and he knew of no good documentation for any such jolt. More likely, he surmised, was a gradual settling of the lunar surface beneath the weight of Luna 9. Again he considered rock dust a logical candidate for the shifting agent. And again he cited tests in his laboratory under lunar-like vacuum conditions to fortify his views. A forty-pound weight (one-sixth as heavy as the earthy 220-pound weight of the Luna 9 ball) had rested securely on rock dust without sinking into the dust when the weight was distributed over a flat surface mathematically comparable to the curved bottom of a ball two feet in diameter. However, when the same weight was moved onto surfaces as small as the feet of an adult human male, the weight sank a foot or more into the dust.

It may be that, in spite of all Professor Gold's experiments and all the infrared and radar readings of the moon, there is some explanation other than dust for the thermal insulation mystery of the moon and for that tantalizing movement of Luna 9 sometime following its moon landing. Is there any really foolproof way to tell?

A toy tractor with treads so placed as to allow movement regardless of the toy's spatial attitude could be landed softly on the moon. It could be equipped to monitor its own tracks. A dusty surface would register tracks clearly, a hard surface would not.

How would the toy be landed?

How was the Luna 9 landed?

Maybe the time has come to begin detailed planning for an international voyage to the moon.



THROUGHOUT the month of February 1966, mail coming into SR's science desk has been heavy with criticism of scientific experiments performed on people who neither know of nor consent to the involvement of their bodies and minds. Widespread admiration has been expressed in these letters for Mr. William A. Hyman, the New York City attorney who insisted on exercising his legal responsibilities as a member of the board of directors of the Jewish Chronic Disease Hospital in Brooklyn. It was in this hospital that twenty-two old and disabled patients were unwittingly exposed to inoculation with live cancer cells.

As a result of Mr. Hyman's inquiry and court proceedings, two physicians—

Dr. Chester A. Southam, noted cancer researcher on the staff of the Sloan-Kettering Cancer Research Center, and Dr. Emanuel Mandel, medical director of the Jewish Chronic Disease Hospital of Brooklyn—were put on probation for one year by the New York State Board of Regents. The Regents said suspension of medical license would be considered if further transgression of professional ethics occurred.

SINCE SR's report on this matter appeared in our issue of February 5, Mr. Hyman has disclosed that three physicians—Drs. Mendel Jacobi, Samuel Rosenfeld, and Hyman Strauss—have been dismissed from their posts at the Brooklyn hospital. The dismissals were issued by Dr. Mandel, against whom the three doctors had testified under a summons from the Attorney General's Office of the State of New York.

In formal papers delivered to Mr. August J. Bardo, director of the office of professional conduct of the New York State Department of Education, Mr. Hyman asked investigation of the following allegations:

FIRST. That the executive committee of the board of directors of the Jewish Chronic Disease Hospital met in the hospital board room on April 21, 1965 with hospital staff physicians who had been invited to attend as guests.

SECOND. That the minutes of this committee meeting include this statement:

The physicians described their feeling of harassment over our permitting the doctors involved in the actions pending in the "Matter of William A. Hyman v. JCDH" to remain on the medical staff. The physicians present suggested that some appropriate action be taken either to censure or dismiss the doctors involved.

It was suggested by the members of the executive committee that a statement of charges be prepared by one or more of the physicians present and that such charges be presented to the executive committee for referral to the legal committee of the board of directors.

THIRD. That "the physicians present" included Dr. Mandel and six others but did not include Drs. Jacobi, Rosenfeld, and Strauss.

FOURTH. That the dismissal of Drs. Jacobi, Rosenfeld, and Strauss occurred with the beginning of the calendar year 1966, within days after the announcement of Dr. Mandel's judgment by the Board of Regents on charges of "fraud and deceit" in the cancer experiment.

Mr. Hyman asked Mr. Bardo for new hearings and a ruling on whether Dr. Mandel's license to practice medicine should not be suspended.

—JOHN LEAR,
Science Editor.



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