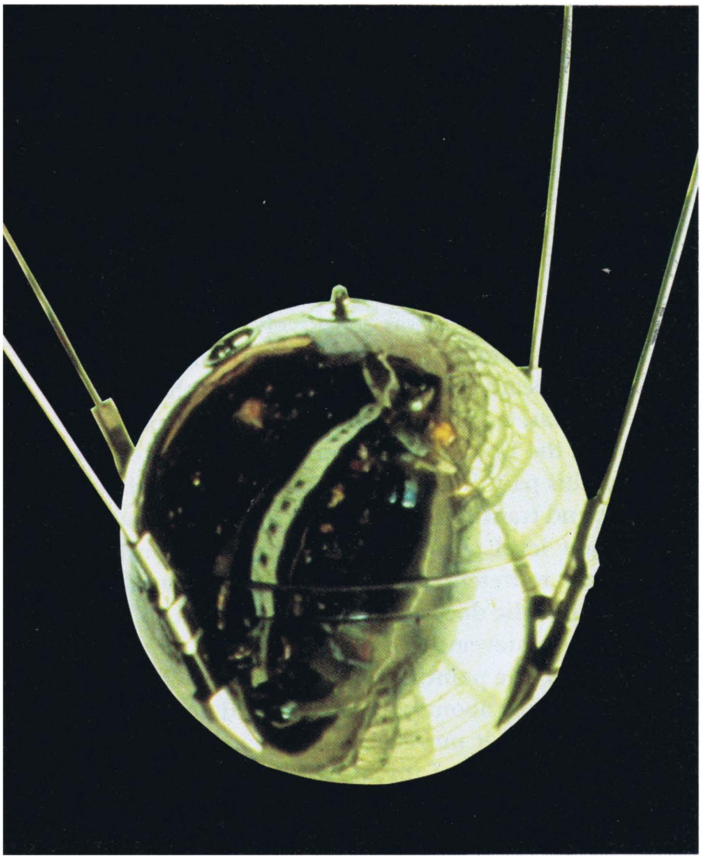


A glittering replica of Sputnik is suspended from ceiling in the National Air and Space Museum.

The Soviet satellite left a trail across the sky in a time exposure made October 8, 1957, in Australia.

By Paul A. Hanle

The beeping ball that started a dash into outer space

Twenty-five years ago the Russians rocketed the first man-made satellite into orbit. Today we still feel the impact of that simple transmitter

On October 4, 1957, the Soviet Union launched into orbit a 184-pound sphere carrying a radio transmitter, enough batteries to run it for about two weeks, and four car-radio-style antennas, swept back to conform to the shape of the nose cone in which it rode atop its launch vehicle.

James Van Allen remembers Sputnik differently from most Americans. On a South Pacific expedition aboard the Navy's U.S.S. *Glacier* to study cosmic rays for the International Geophysical Year (IGY) at the time of its launch, he heard the news on the Armed Forces Radio.

"Before I swallowed it, I wanted to personally confirm it," he recalled in an interview at the Smithsonian National Air and Space Museum (NASM). The ship's radioman picked up a signal at the right frequency, and soon Van Allen and his team were listening to Sputnik's steady beeping with astonishment at the strength of the signal. Checking its orbital period, the length of the passes during which the ship's receiver held the

Reaction of the news media is typified by cartoon published in *New York Times* on October 13, 1957.

signal, and the change in frequency of the signal as it passed like a fast-moving train, they convinced themselves that this was in fact the Russian satellite.

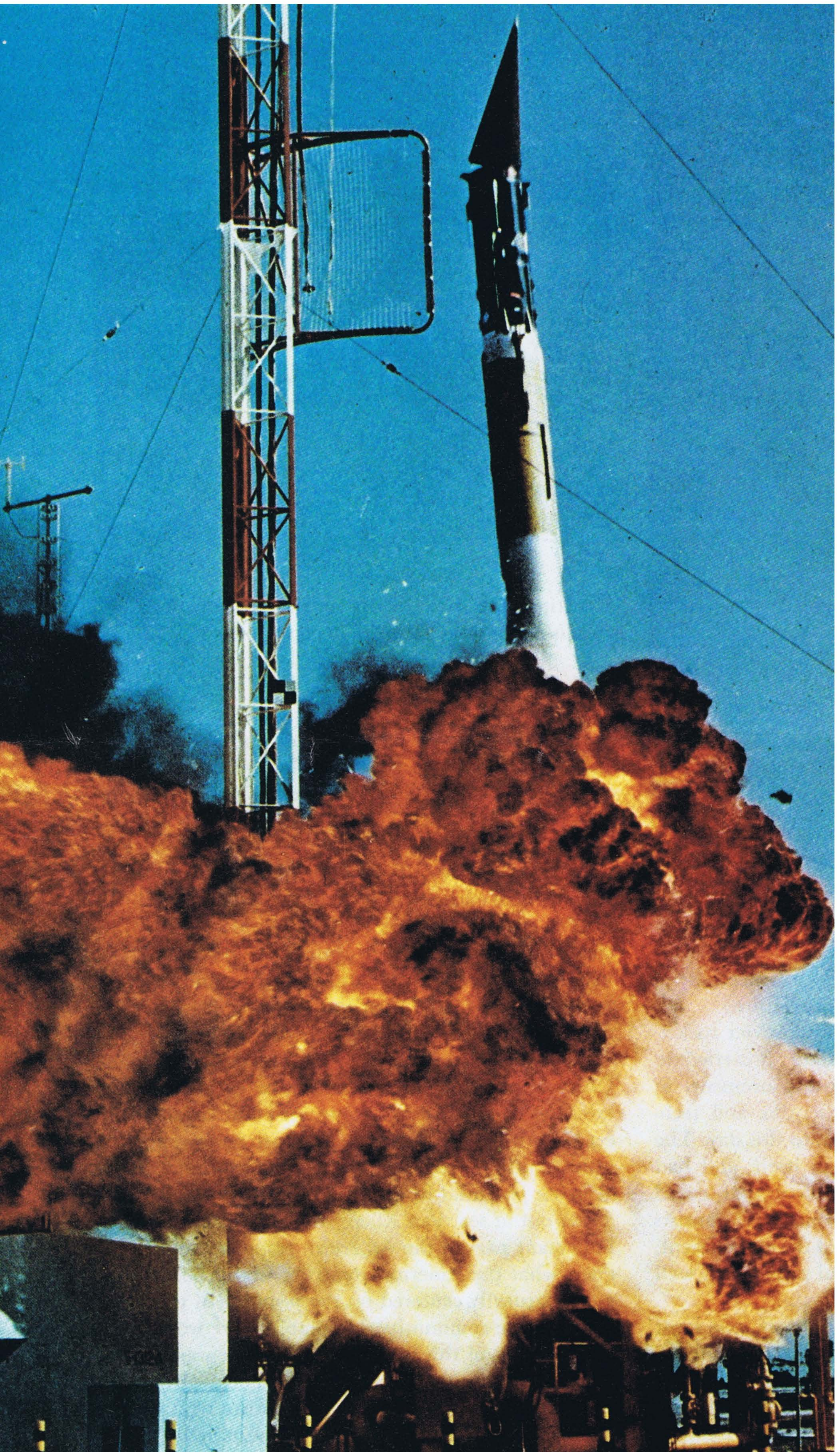
Sputnik demonstrated the muscle of Soviet rocketry, but the satellite was mainly for show: it carried no scientific instruments and took no measurements in space. The launch intensified a scientific and technological competition that continues to this day. The United States was close to a launch itself, and had intended all along to orbit apparatus that could measure and record the space environment. Scientists like Van Allen wanted to show, as did the government, that space could be used for peaceful purposes as well as for the missiles of war.

To appreciate the significance of Sputnik, one must look back at the international politics of the era. America was engaged in an intense rivalry with the Soviet Union, a competition that seemed to hold our very survival in the balance. Bellicose and petulant, Soviet Premier Nikita Khrushchev had declared that the socialist states would overtake the capitalists as world leaders in economic and technological development. His famous "We will bury you" remark could be taken by a jittery, polarized West as a direct military threat.

In this climate the launch of Sputnik reverberated throughout the country as few other events of the day. (Some of the excitement is captured in a new exhibit at NASM called "25 Years of Space Exploration." The space spectaculars are set against the background of what was happening in culture, politics and science.)

Interest was mixed with alarm. Asked if the satellite gave any military advantage to the Soviets, Fred L. Whipple, director of the Smithsonian Astrophysical Observatory, who played a key role in tracking the first satellites by organizing a volunteer effort called "Project Moonwatch," could not offer much reassurance: "It is not a military advantage as such, but it indicates the Russian potential in the area of missiles."

Far out at sea, Van Allen, who would play such an important part in the American response, could only guess what the American reaction would be, and his guess naturally centered on the response of the scientific satellite community. Inevitably there would be a reevaluation of this nation's satellite program. In his field notebook (to be cited in his book, *Origins of Magnetospheric Physics,* being published next year by Smithsonian Institution Press), he permitted himself some unscientific observations: "Confirms my disgust



with . . . decision to favor N.R.L. [the Naval Research Laboratory's Vanguard satellite] over the Redstone proposal of Sept. 1955!!"

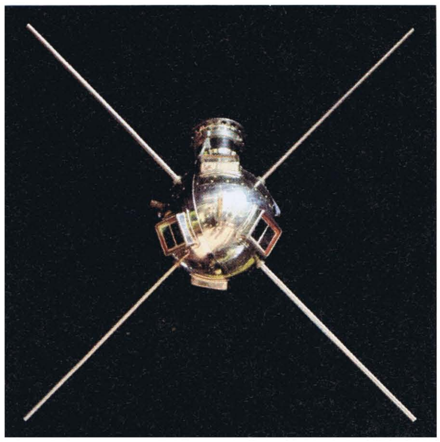
He rued his own bad luck at being so far away from the action. But he could not suppress his excitement at the technological feat, writing at one point, "Weight 83.6 kilograms (Wow!)" and at another, "Brilliant achievement!" The thing was nine times heavier than the U.S. satellite would be, implying a gigantic launch vehicle, a point whose significance Van Allen understood perfectly well.

Cosmic-ray physicist James Van Allen was no newcomer to rocket research in 1957. Easygoing and self-effacing, he nevertheless always had strong ideas about space science. He had been given a priority position for his scientific experiment on the Vanguard project for the IGY. The position was natural, for his researches dated to the earliest efforts after World War II to send scientific payloads into space atop captured German V-2 rockets. In the late 1940s, an American rocket built to Van Allen's specifications, the Aerobee, carried his cosmic-ray experiments to about 70 miles altitude.

Moving to the University of Iowa in 1951, where he has remained ever since, Van Allen brought to reality the idea that a small rocket, lifted ten or 15 miles by a balloon, could then reach great heights by avoiding the aerodynamic drag of high-speed flight through the dense lower atmosphere. Van Allen's "rockoons" carried instruments 60 miles into space.

With this background, James Van Allen and his research associates presented an extraordinary combination of scientific achievement, recognition and hard engineering experience with rockets. But aboard the *Glacier* in early October 1957, Van Allen wondered if his experiment would really fly on Vanguard—or would all bets be

Its nose cone beginning to topple, Vanguard blows up as nation watches.



Vanguard's small payload, TV-3, would have been America's first satellite.

off in the aftermath of Sputnik? Even as he steamed toward Antarctica, he knew that there would be a clamor to intensify our efforts in space.

Although clearly uneasy about Sputnik "flying" over American cities several times a day, U.S. officials, taking their cue from President Eisenhower—who went golfing October 5—at first remained coolly resolved not to accelerate our own satellite launch program.

But the mood changed quickly. The press led a growing attack on American scientific complacency and the allegedly poor science education of the younger generation. *Time* assessed the status of U.S. science in its cover story of November 18, 1957, reporting that Russia was graduating more than twice as many scientists and engineers per year as was the United States. It concluded, "Now the U.S. has to live with the uncomfortable realization that Russia is racing with clenched-teeth determination to surpass the West in science—and is rapidly narrowing the West's shielding lead."

In the weeks after Sputnik, Eisenhower met with scientific advisers, including Detlev Bronk, president of

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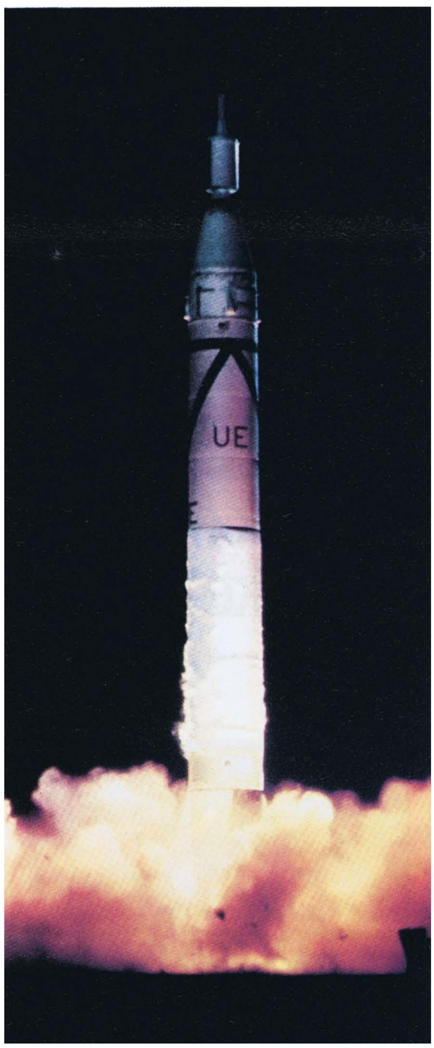
the National Academy of Sciences, and those working for the Office of Defense Mobilization. It was at Ike's meeting with this advisory committee on October 15 that chairman I. I. Rabi raised the idea of creating the post of Special Assistant to the President for Science and Technology. This led to Eisenhower's appointment of James R. Killian, president of MIT, to the post.

In less than five months, Killian and his advisers put together a blueprint for space exploration for the next two decades. Called "Introduction to Outer Space," it described what was to come: hard, soft and manned landings on the moon; robots' journeys to Mars and the other planets; the measurement of the Earth's gravity and magnetic field; a space-based test of Einstein's General Theory of Relativity; tests of how life gets on in space. Satellites that look both downward and upward—meteorological and astronomical types—were predicted, as were communications satellites for "intercontinental

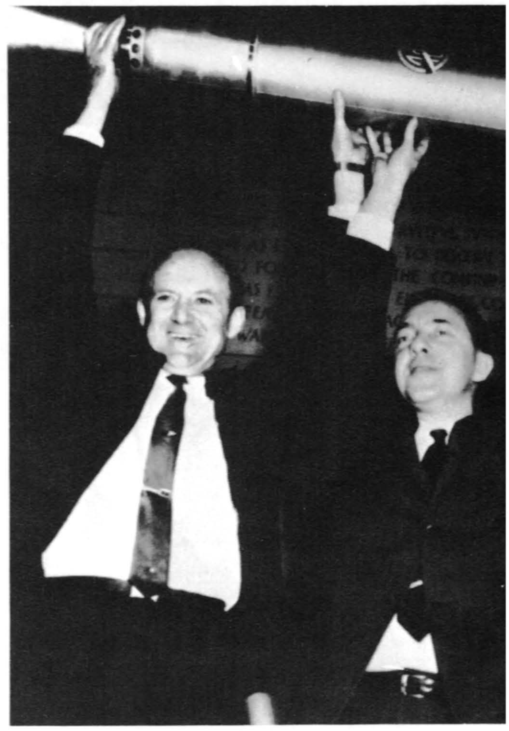
Army team in 1956 (counterclockwise from top left) was Holger Toftoy, Ernst Stuhlinger, Hermann Oberth, Wernher von Braun and Robert Lusser.

television." Even reconnaissance satellites, whose use in monitoring arms agreements was a state secret until 1978, were foreseen in this policy-making report.

These predictions would materialize as the projects of the 1960s and '70s: Ranger, Surveyor and Apollo to the moon; Skylab; Mariner, Pioneer, Viking and Voyager to the planets; the Explorers, Orbiting Astronomical Observatories, and other scientific satellites; sensing and communications satellites such as TIROS, Nimbus, Marisat, Intelsat and Landsat—a scientific and technological explosion that has spawned a whole industry. In



The Army's Jupiter C successfully launches Explorer I on January 31, 1958.



At the Explorer I news conference, scientists (from left) William Pickering,

late 1957, however, before this plan was even drafted, the nation's first priority in space was to get a satellite into orbit as soon as possible.

The United States had been rumbling, like a volcano about to erupt, with the fire and smoke of its own launch vehicles when Sputnik went up. In July 1955 the nation had committed itself to launching a satellite during the IGY. Three proposals were considered. The Air Force's Atlas would become a mighty intercontinental ballistic missile and could place perhaps half a ton or more into orbit. But it was not yet ready and could not be diverted from its military role anyway. The Army's modified Redstone Orbiter and the Naval Research Laboratory's Vanguard remained to compete head to head.

Deliberating on the pros and cons of each in the late summer of 1955, a scientific panel headed by Homer J. Stewart of Caltech chose Vanguard for the first American satellite launch. This would be a civilian space effort and would be protected from further competition with the Army and the Air Force. Two successful launches of first stages moved Vanguard toward a

James Van Allen and Wernher von Braun raise high a model of the satellite.

late October test in full configuration. But Vanguard had fallen behind schedule, in part because of under-funding, and a satellite launch was still months away on October 4.

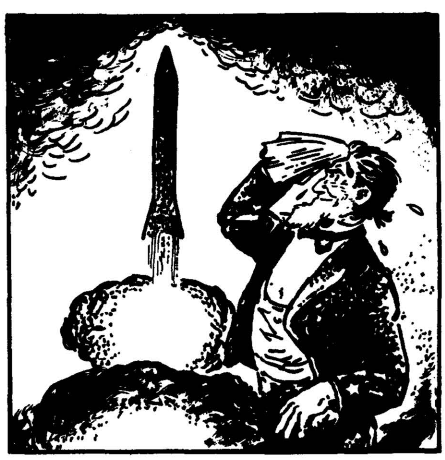
The Orbiter, no longer in the running for use as a satellite launcher in 1955, was being developed as Jupiter C for testing the reentry of warheads from space—a way to keep the satellite project in the works as well. Although Jupiter C was a workable four-stage launch vehicle, which proved itself in a successful flight with an inert final stage in September 1956, Redstone developer Wernher von Braun had been ordered not to launch a satellite at that time, partly to avoid stealing the thunder of the civilian team. So the Jupiter C was only a potential satellite launch vehicle when Sputnik went into orbit.

Van Allen was in the South Pacific when Sputnik went up, but William Pickering, director of Caltech's Jet Propulsion Laboratory in Pasadena, and von Braun, the courtly, articulate developer of the V-2 and head of the rocket team based in Huntsville, Alabama, took hold of the situation in his place. Quickly they set about convincing the Army and the government that Jupiter C should be made a backup to Vanguard, in spite of the President's earlier wish to keep the space program free of military connections. The Soviet success had changed the atmosphere. Seeing both need and opportunity, the Department of Defense gave the go-ahead three weeks after Sputnik.

Pickering, an unflappable New Zealander, sent a radiotelegram to the one scientist, Van Allen, who had had the foresight (or prudence) to design his experiment to fit both Vanguard and the Jet Propulsion Laboratory's satellite, Explorer. In early November, von Braun promised that he could launch a U.S. satellite within 90 days. The goal was to launch by January 29, 1958, and no time could be wasted. Van Allen agreed to Pickering's proposal on November 14. The bargain was struck.

Van Allen moved his experiment just in time. On December 6 an attempted launching of Vanguard turned into televised humiliation when the rocket exploded on the pad (p. 150). The Vanguard team continued working toward another launch in late January, but meanwhile the Army was quietly building up its Explorer program.

By agreement among Van Allen, Pickering and the Army, there would be three Iowa payloads on three dif-



Cartoon expressed Uncle Sam's relief at the successful Explorer I flight.

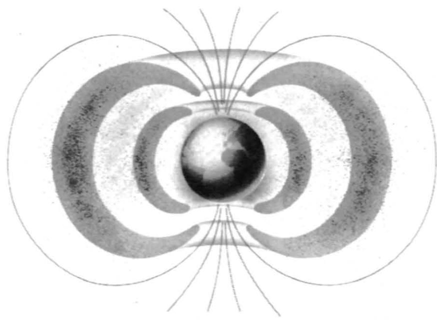
In New Mexico, observers follow satellite with special camera deployed by Smithsonian Astrophysical Observatory.

ferent vehicles. The first was essentially a Geiger counter to measure cosmic radiation, and a radio transmitter to get the measurements back to Earth. This payload was the same as the planned Vanguard experiment, but without a tiny tape recorder to store the data when the satellite was out of range of radio ground stations.

The second and third payloads carried the same components as the first, but with the tape recorder as well, which would prove crucial to the scientific success of the experiments. For each 95-minute orbit the recorder could store the measurements, then play them back in six minutes to a ground station as the satellite passed overhead.

The Jet Propulsion Laboratory called the plan to fly the first payload on schedule, but without the recorder, "Deal I," and to fly the next two missions, *with* it, "Deal II." For the Iowa team, the terms soon came to mean the payloads themselves.

Explorer I, with Deal I, went up late on the evening of January 31, 1958. The public uproar that followed astonished Van Allen. Led into a 1:30 A.M. press conference at the National Academy of Sciences with von Braun and Pickering, he found a room full of reporters and photographers (pp. 158-59). Van Allen remembers: "I wasn't cynical about it. We were treated like the heroes who raised the flag over Iwo Jima, sort of temporary heroes, rescuing the honor of the United States in this great Cold War with Russia by having a successful satellite."



In 1958, Explorers I and III discovered the inner of Earth's radiation belts.

While Sputnik was a massive, beeping, but otherwise inert, sphere that mainly demonstrated the powerful launch capacity of Soviet missiles, the U.S. satellites were to show superior scientific capability. "It was very deeply imbedded in the whole U.S. posture with respect to producing satellites that they were to be nonmilitaristic. As part of the IGY compact . . . they were to be scientific," Van Allen recalls. It was extremely important for the Jupiter C, a modified Intermediate Range Ballistic Missile (IRBM), to carry a scientific payload and help America maintain this peaceable posture.

Because it carried no recorder, Explorer I produced meager data that raised a lot of questions. It appeared to show gaps in the radiation surrounding the Earth. Indeed, at one point, Pickering believed that the apparatus was not working.

Explorer II should have provided the answers when it went up just over a month later—but it came right down again. The final stage of the rocket had failed to ignite and the payload fell into the sea.

Explorer III went off without a hitch, achieving orbit on March 26, 1958. It carried the recorder that would be so important in understanding the data from Explorer I.

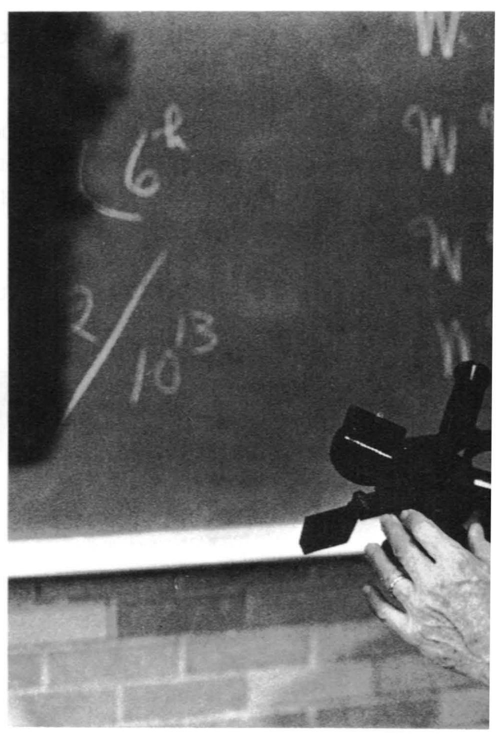
Explorer III resolved the situation. The first continuous observations of radiation, played back from the recorder on Explorer III, arrived in

Van Allen's hands in Washington two days after the launch.

Working in his hotel room until three the next morning, hot on the trail of the explanation for the periodic blanking out of the instrument that Pickering first described, Van Allen finally convinced himself "that our instruments on both Explorers I and III were working properly but that we were encountering a mysterious physical effect of a real nature." Putting this continuous data together with a ground test of the instruments at very high levels of radiation, Van Allen and his graduate student assistants learned that when the instrument registered no counts whatsoever it was "saturating," or blanking out, at incredibly high levels of radiation. In effect, the instrument could not cope when the radiation reached levels 1,000 times greater than it was designed for.

Now Van Allen had the key, but hard work was still necessary to piece together the location of the radiation in space. Was all of space "radioactive," as his assistant Ernie Ray had facetiously exclaimed? Hardly. Sometimes the counting rate fell quite low. Was the Earth completely surrounded by this radiation? Not at high latitudes. Did the radiation extend outward to an indefinite distance? One

His name may be enshrined in space, but Van Allen still enjoys teaching astronomy.



could not say for sure, but it seemed to increase slowly, then jump dramatically upward, then decrease once again as the satellite moved in its elliptical orbit away from, then toward, the Earth.

Van Allen announced his preliminary findings—results that in their basics have withstood the test of time —on May 1, 1958. The Earth was encircled by radiation, charged particles trapped in its magnetic field (p. 164).

As he recounts, "A reporter asked, 'Do you mean like a belt?' " Indeed. The word stuck, with the eponymous designation that is usual for scientific discoveries. This was to be the Van Allen Radiation Belt.

The belt became, in the furor that followed the launches of Sputnik and Explorer, the first major scientific discovery of the "Space Age." As important as it was from a purely scientific standpoint, the great attention that it enjoyed derived mostly from the technical achievement of Van Allen and America in the face of the Soviet challenge.

The next months would see the establishment of the National Aeronautics and Space Administration. With this new organization, the United States would set about taking us to the moon, the planets, and farther into the infinite reaches of space.