James A. Van Allen (1914–2006)

From Iowa to APL to Iowa to Space

James Van Allen earned the moniker "the father of space science" for developing instruments used aboard the first U.S. satellites that led to the discovery of the Earth-encircling radiation zones. These zones became known as the Van Allen belts.

James Van Allen was born in 1914 to Alfred Morris and Alma Olney Van Allen. After receiving a B.S. in physics from Iowa Wesleyan College in 1935, he went on to earn advanced degrees from the University of Iowa (an M.S. in 1936 and a Ph.D. in experimental nuclear physics in 1939). After completing his doctorate, Van Allen first went to work for the Carnegie Institution of Washington and then in the spring of 1942, after the outbreak of World War II, for the Applied Physics Laboratory (APL). The Laboratory, established under the auspices of Johns Hopkins University, was tasked with developing the concept of the proximity fuze and introducing it to the Navy for use in projectiles of the large antiaircraft guns on its combatant ships. By November 1942, APL had achieved its goal, and Van Allen, who along with two other APL employees had been commissioned as a junior-grade lieutenant

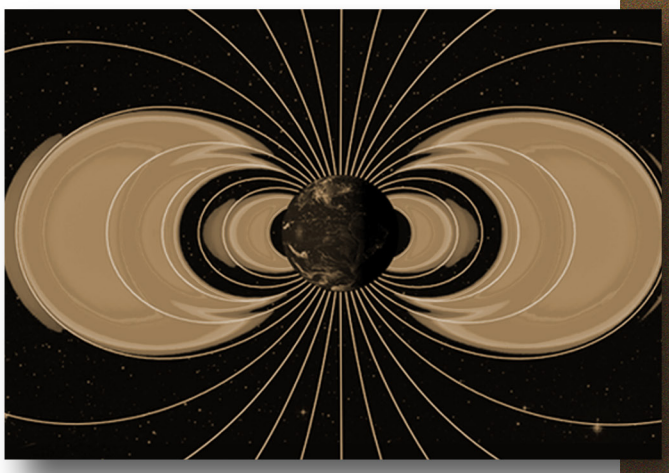
in the United States Naval Reserve, sailed on the USS *Republic* from San Francisco to the South Pacific with a stock of nearly 6,000 proximity fuzed projectiles for the Navy. After the war, he came back to APL, where he met Abigail Fithian Halsey, a mathematician and data analyst also working at the Laboratory, when the two were in a fender bender on the way to work. They married in 1945 and had five children.

Van Allen's experiences working on the proximity fuze prepared him well for many of the tasks he and his APL team set off on after the war. The High-Altitude Research Group, founded and led by Van Allen, conducted many experiments with captured German V-2 rockets and Aerobee rockets to observe cosmic rays and the solar spectrum and to obtain pictures of Earth's curved horizon.

In late 1950, Van Allen returned to Iowa to take a position as a professor and head of the Department of Physics at his alma mater. There, he continued his high-altitude research using the domestic Aerobee rocket that he had helped to develop while at APL—work that paved the way for his contributions to the country's approaching entry into the space age. Van Allen was the chief proponent for creation of the Rocket and Satellite Research Panel, which evolved from the U.S. V-2 Rocket Panel that had been founded to direct high-altitude research. He eventually became chair of the panel. The group organized U.S. participation in the 1957/1958 International Geophysical Year (IGY), during which members actively promoted the use of scientific satellites around Earth. In addition, they spearheaded the science base of NASA, also established in 1958.

By 1956, Van Allen had already submitted a formal proposal to the IGY for inclusion of an instrument on an Earth satellite. The suggested instrument flew on the payload of the inaugural flight of the Army's Jupiter C rocket on 31 January 1958. This first U.S. satellite, Explorer 1, worked well, but the data were not readily interpretable. Thus, these measurements were later combined with those of Explorer III, which carried a wire recorder and was capable of providing global coverage. The combination of the two data sets led to the discovery of the radiation belts that bear Van Allen's name—vast regions of space inhabited mostly by protons and electrons trapped in the Earth's magnetic field with energies extending to tens of millions of electronvolts. The discovery was publicly announced at the National Academy of Sciences on 1 May 1958. By late 1958, NASA had taken over most U.S. space research. Under NASA support, the Iowa team built and flew instruments and entire satellites, with some data received through makeshift antennas near Iowa City. These instruments made seminal discoveries that illuminated plasma processes in every region of Earth's magnetosphere.

During this time, researchers were anxious to investigate potential magnetospheres around other planets, as well as the properties of the interplanetary medium in between. Within 17 months of my arrival in Iowa City as a graduate student, Van Allen asked me to be a co-investigator on the first U.S. mission to Mars. There was a need to design a detector that



could discriminate protons from electrons, something the Geiger-Mueller tubes flown until that time could not accomplish. The launch of Mariners 3 and 4 was only 20 months away, in November 1964. I was able to get a solid-state detector to work about a month before launch; it was designed to measure only protons and, when the data were combined with those of a G-M counter that was sensitive to all forms of radiation, the desired separation would be possible. Mariner 3 failed, but Mariner 4 went on to Mars and, surprisingly, our detectors did not find a Martian magnetosphere or equivalent Van Allen belts. Nevertheless, the Mariner 4 mission made several discoveries en route, including the first ever electron emissions from solar flares, and produced an 8-month record of solar X-ray flare activity. A similar detector package was built for Mariner 5 and flew by Venus in 1967 (by this time I was an assistant professor at Iowa), but no Van Allen belts were found there either. These "null" results in finding magnetospheres at Earth's neighbors only accelerated the search for such regions in the outer planets, and Van Allen's detectors on the Pioneer 10 and 11 spacecraft were the first to characterize the huge magnetospheres of Jupiter and Saturn.

It is fair to say that the Radiation Belt Storm Probes (RBSP) program is the most comprehensive mission set, since Van Allen's initial discovery, to investigate the physical processes taking place in Earth's near magnetosphere. That the spacecraft were built at and are operated by APL, where Van Allen started his space career, and include instruments from both Iowa and APL scientists is ample justification for renaming the program Van Allen Probes. Honoring the father of space science in this way celebrates the long and illustrious trajectory of the man we remember not only as the space pioneer for this nation but also as a "plank owner" of APL. It has been a terrific privilege to have had such an outstanding teacher, mentor, and friend.

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Images, clockwise, starting on page 162. (1) James Van Allen. (2) Members of the high-altitutde research group around V-2 rocket no. 17 before its shipment to White Sands for a test launch. (3) Van Allen with the nose cone of a German V-2 rocket. (4) The Van Allen Probes atop an Atlas V rocket on the launch pad at Cape Canaveral. (5) Van Allen (left), Tom Armstrong (grad student from Kansas; center), and Stamatios Krimigis (right) with the Explorer 33 instrument in 1965. (6) Krimigis and Van Allen at APL in the early 1980s. (7) Van Allen Probes data, recolored.