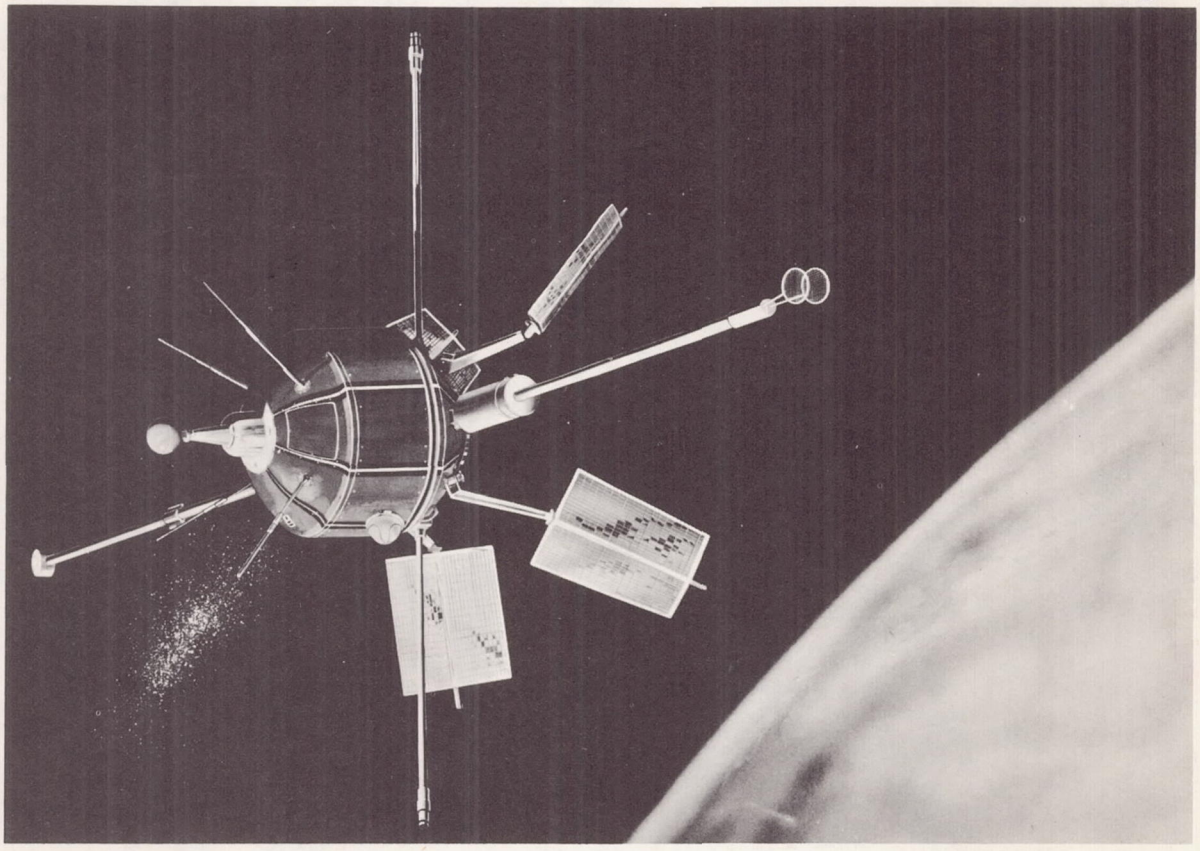
NASA FACTS

AN EDUCATIONAL SERVICES PUBLICATION OF THE NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

A-R-I-E-L

FIRST INTERNATIONAL SATELLITE



ARIEL IN ORBIT—Artist's conception of the United Kingdom-United States satellite in space.

INTERNATIONAL COOPERATION

Ariel, the joint United Kingdom—United States satellite launched April 26, 1962, dramatizes the steadily expanding program of international cooperation in the peaceful exploration and utilization of space. Named by the United Kingdom's Prime Minister Harold MacMillan for the sprite in Shakespeare's *Tempest,* Ariel is the first of several joint satellite projects planned by the United States and other nations. It is also the world's first internationally conceived and executed satellite.

This joint United Kingdom—United States satellite developed from a proposal by United States representatives at the March 1959 meeting of COSPAR, the Committee on Space Research of the International Council of Scientific Unions. At that meeting, the United States of-

DEFINITIONS

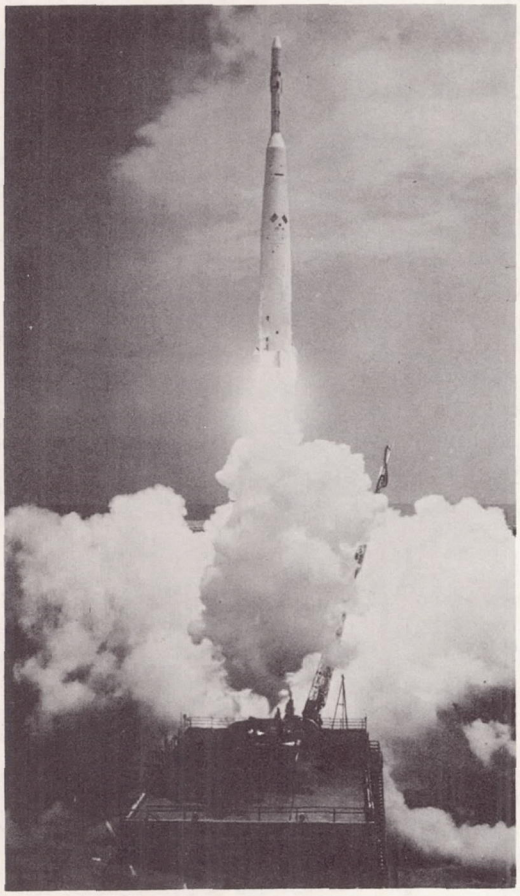
Ionosphere—The layer of atmosphere beginning about 40 miles above the earth's surface, consisting of ionized air, which can reflect certain radio signals.

Ion—A molecule or atom which has lost or gained an electron, thereby acquiring an electric charge.

Proton—A positively-charged constituent of an atom; the nucleus of the light isotope of hydrogen.

Electron—The smallest known particle of negative electricity. It is a constituent of the atom.

fered to launch payloads or complete satellites prepared by foreign scientists. The United Kingdom was one of a number of nations to accept the offer.



LIFT-OFF—NASA Delta launch vehicle carrying British Ariel payload rockets from launch pad at Cape Canaveral, Florida, 1 p.m. E.S.T., April 26, 1962.

SCIENTIFIC OBJECTIVES

Ariel is designed chiefly to contribute to man's knowledge of the ionosphere, an electrified region of the atmosphere extending from about 40 to several hundred miles above earth.

The ionosphere is formed by absorption in the earth's atmosphere of X-rays and ultraviolet light from the sun and by impact of solar energetic particles (mainly protons) on the atmosphere. As a result, atmospheric molecules are broken into free electrons and positively charged ions. (See DEFINITIONS.)

"This joint enterprise reflects great credit on the British and American scientists and technicians concerned. It provides a fine start to the United States program of international cooperation in space."

Harold MacMillan
Prime Minister of the
United Kingdom

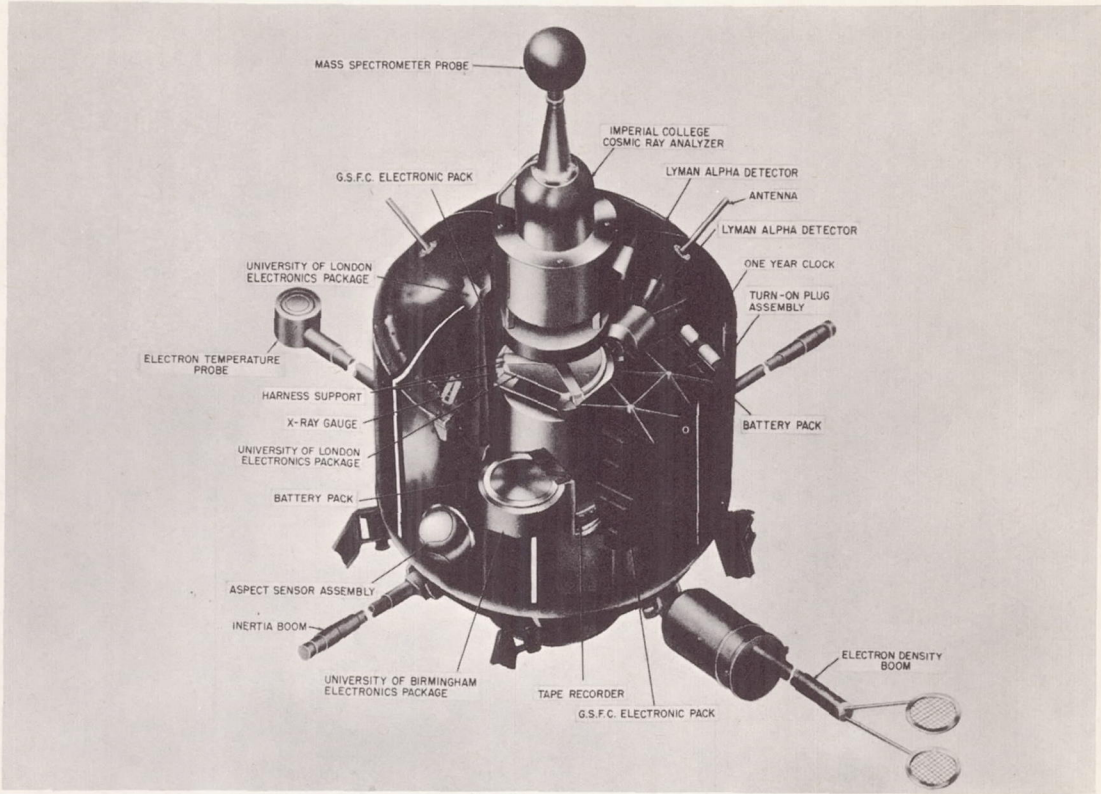
From a practical standpoint, the ionosphere serves as a radio mirror for reflecting messages from one point on earth to another. A major drawback to its use in radio communications is that its characteristics change with season, time of day, and solar events. Solar flares so disrupt the ionosphere that it absorbs radio waves, preventing messages from being reflected to the receiver.

Dependence on the ionosphere for communication will be diminished when communications satellite systems are perfected. However, demand for communications channels is climbing so rapidly that reliance on the ionosphere for some communication is expected to continue indefinitely.

Ariel's instruments measure densities and temperatures of electrons and characteristics, quantity, and distribution of ions. They also monitor solar X-rays and ultraviolet light to correlate behavior of the sun with changes in the ionosphere.

Another Ariel experiment is designed to study the relationship between disturbances on the sun and cosmic rays in the earth's vicinity. Cosmic rays consist of a mixture of protons, nuclei of elements such as hydrogen, and other particles that have been accelerated to enormous energies.

Eruptions of sunspots or solar flares are usually followed by a decrease in the intensity of cosmic radiation reaching the earth. It is theorized that during solar disturbances, the sun hurls low-energy protons which drag the solar magnetic field with them. When this field extends toward earth, it deflects some of the cosmic particles, reducing the quantity reaching earth.



INSIDE VIEW—Cutaway of Ariel showing principal instrumentation prepared by the United Kingdom and equipment prepared by the United States.

ORBITAL ELEMENTS

Ariel orbits the earth about every 101 minutes. Its apogee (farthest flight from earth) is approximately 760 miles; its perigee (closest approach to earth) about 244 miles. Its orbit is inclined about 54 degrees to the equator, meaning that it passes over an area stretching from 54 degrees north to 54 degrees south latitude.

STRUCTURAL MEASUREMENTS

The 132-pound satellite is 23 inches in diameter and $10\frac{11}{16}$ inches high. In orbit, with solar cell paddles, booms, and antennas extended, it measures about 10 feet across. (Solar cells convert sunlight to electricity for running the satellite's instruments.)

PRINCIPAL PARTICIPANTS

Scientists of the United Kingdom developed and built the experiments. The Royal Society's British National Committee on Space Research selected experiments in consultation with the National Aeronautics and Space Administration (NASA). The University of Birmingham prepared the equipment to measure electron density. Imperial College, London, developed the instruments to gauge intensities of cosmic rays. University College, London, made the instruments for measuring temperatures and concentrations of ions and electrons in earth's vicinity and intensities of X-rays and ultraviolet radiation from the sun. The University of Leicester collaborated in the X-ray experiment.

The National Aeronautics and Space Act of 1958 requires that NASA "provide for the widest practicable and appropriate dissemination of its activities and the results thereof." The act also requires that NASA work with nationals of other countries in development of space technology and "in the peaceful application of the results thereof."

NASA's Goddard Space Flight Center, Greenbelt, Maryland, was responsible for the satellite's structure and auxiliary instrumentation including telemetry, communication, recording, and power supply. NASA also supplied the Delta launch vehicle, the facilities, and the services for placing Ariel in orbit.

COOPERATIVE SPACE PROGRAMS

The countries listed have cooperative space programs with the United States in the categories noted:

Satellites

Canada, United Kingdom, and Italy. (Others contemplated.)

Sounding Rockets

Argentina, Australia, Canada, Denmark, France, Italy, Japan, New Zealand, Norway, Pakistan, Sweden

Ground-Based Meteorology

Argentina, Australia, Austria, Belgium, Brazil, British East Africa, Burma, Chad, China, Colombia, Costa Rica, Czechoslovakia, El Salvador, Federation of Rhodesia and Nyasaland, France, Hong Kong, Hungary, Iceland, India, Iraq, Ireland, Japan, Mauritius, Netherlands, Netherlands New Guinea, New Zealand, Poland, Portugal, Republic of South Africa, Sudan, Switzerland, Thailand, United Arab Republic, United Kingdom, West Indies Federation

Communications

Brazil, Federal Republic of Germany, France, Italy, United Kingdom

Tracking and Acquiring Data from Spacecraft

Argentina, Australia, Brazil, Canada, Canton Is., Chile, China, Ecuador, Federal Republic of Germany, India, Iran, Israel, Japan, Mexico, Netherlands, Nigeria, Peru, Philippines, Portugal, Republic of South Africa, Spain, United Kingdom, Zanzibar

Goddard Space Flight Center processes transmissions from the satellite and sends them to the United Kingdom for analysis.

Scientific direction of Project Ariel is provided by Homer E. Newell, Director, Office of Space Sciences, NASA Headquarters, and by Sir Harrie Massey, Chairman of the British National Committee on Space Research. Project managers are M. O. Robins, University College, London, and Robert C. Baumann, Goddard Space Flight Center.

EIGHT COUNTRIES TRACK ARIEL

Minitrack stations in eight nations are cooperating in tracking and gathering data from the satellite. The Minitrack network includes stations at Antofagasta, Chile; Blossom Point, Maryland; Esselen Park, Republic of South Africa; East Grand Forks, Minn.; Fairbanks, Alaska; Fort Myers, Fla.; Mohave, Calif.; Lima, Peru; Quito, Ecuador; Santiago, Chile; St. Johns, Newfoundland; Winkfield, England; Woomera, Australia. In addition, stations of the British Department of Scientific and Industrial Research

For sale by the Superintendent of Documents, U.S. Government Printing Office
Washington 25, D.C. - Price 5 cents

"Space science is one science that is obviously international. You have to work on a global scale to do the job properly."

Sir Harrie Massey
Chairman of the British
Space Research Committee

are participating in the experiment. All stations funnel data collected into the Goddard Space Flight Center.

ARIEL WILL BROADCAST FOR ONE YEAR

The satellite is designed to transmit information for a year. Redundant switching systems have been installed to assure that it goes off the air on schedule, leaving its radio channel free for other experiments. The satellite is expected to remain in orbit for several years.

RESULTS TO BE SHARED WITH WORLD

Results of Ariel experiments, expected to contribute significantly to scientific knowledge, will be shared with the world scientific community. In perspective, however, the most important result of this first international satellite may well be the great step forward that it represents toward global cooperation in space. It is an outstanding example of how peoples can unite their energies and talents in future space projects for the benefit of all mankind.

TELEGRAM FROM UNITED KINGDOM MINISTER FOR SCIENCE

JAMES E. WEBB, ADMINISTRATOR
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
WASHINGTON, D.C.

I SEND YOU MY FULLEST CONGRATULATIONS ON OUR FIRST JOINT SATELLITE. WE OWE YOU A GREAT DEBT OF GRATITUDE FOR THIS OPPORTUNITY; IT WILL ADD IMMENSELY TO THE WARMTH OF ANGLO-AMERICAN RELATIONS, AND SETS AN EXAMPLE TO THE WORLD IN INTERNATIONAL COOPERATION IN SCIENTIFIC SPACE RESEARCH.

FINALLY, ON BEHALF OF THE AMBASSADOR, I WOULD LIKE TO EXTEND THE EMBASSY'S WARMEST CONGRATULATIONS TO ALL CONCERNED IN THIS HIGHLY SUCCESSFUL VENTURE AND IN SHAKESPEARE'S WORDS, TO SALUTE ARIEL: "THEN TO THE ELEMENTS BE FREE, AND FARE THEE WELL."

LORD HAILSHAM
MINISTER FOR SCIENCE

MAGNETIC FIELDS FOUND EVERYWHERE IN SPACE

Data from Mariner's magnetometer, an instrument that detects and gauges the force and direction of magnetic fields, were remarkable in their great number and continuity. Mariner reported that magnetic fields were nearly always present as it raced through interplanetary space.

Scientists believe that the interplanetary magnetic fields are parts of the sun's magnetic field that the solar wind has distributed throughout space. Typically, the interplanetary magnetic fields were found to be weak compared to earth's. Generally, they ranged from five to ten gamma, with precipitous increases to 25 or more gamma following sudden solar disturbances.

COSMIC RADIATION IN INTERPLANETARY SPACE

During its entire flight, Mariner reported about the same amount and intensity of cosmic radiation. This constancy is considered a significant addition to scientific knowledge; but its implications will have to be clarified by additional experiments.

Cosmic rays are made up of protons (nuclei of hydrogen atoms), alpha particles (nuclei of helium atoms), nuclei of atoms heavier than hydrogen and helium, and electrons. They have velocities almost as great as the speed of light (about 186,000 miles per second) and energies in the millions, billions, and trillions of electron volts. (The electron volt is a scientific measurement unit for energies of atomic particles.)

Cosmic rays are the most penetrating kind of radiation, theoretically being able to pass through lead walls as thick as a thousand feet. Most cosmic rays come from outside of the solar system, usually from within our vast Milky Way galaxy but sometimes from other galaxies. Our own sun produces some cosmic rays, particularly during solar flares and other disturbances.

Both cosmic rays and the matter in the solar wind are atomic particles. However, solar wind particles have comparatively low energies, in the hundreds and thousands of electron volts. Despite the great disparity in individual energies, the aggregate energy of the solar wind is far greater than that of all cosmic rays in the region of the solar system studied by scientific spacecraft. This is because, in this region at least, solar wind particles outnumber cosmic ray particles by about a billion to one.

Mariner reported a scarcity of cosmic ray protons below the level of 800 million electron volts. This scarcity is attributed to interplanetary magnetic fields that permeate the solar system and deflect lower-energy cosmic rays.

If a space traveler had journeyed to Venus at the time of the Mariner flight, he would have absorbed a total of 3 roentgens of radiation. This dosage is well within the tolerable limits for man during a four-month period.

MICROMETEOROID IMPACTS FEW

In 1700 hours of recorded data, Mariner registered only two impacts with micrometeoroids—tiny bits of matter in space. Comparison of these data with information from earth satellites would indicate that micrometeoroids are 10,000 times more abundant near earth than along Mariner's trajectory in interplanetary space. Moreover, no concentration of micrometeoroids was detected around Venus such as occurs around earth.

Information about micrometeoroids is of practical importance in design of spacecraft and is believed essential to study of the origin and evolution of the solar system.

TRACKING DATA ADDING TO KNOWLEDGE

The precise tracking data acquired through the Mariner II experiment have provided basic information that is contributing to refinement of important measurements. Among them: the mass of the moon; the mass of Venus; the Astronomical Unit (AU) which is the mean distance from earth to sun and the yardstick for measuring distance in the solar system; and the exact locations of spacecraft tracking stations on earth.

These figures not only will increase scientific knowledge but also are vital to planning of manned lunar and interplanetary voyages.

MARINER ESTABLISHED NEW COMMUNICATIONS RECORD

Contact was maintained with Mariner II until it was 53.9 million miles from earth. This shattered the previous long-distance communications