Mariner IV Mission

Scientifically, the results of the Mariner IV mission constitute the most important advance in space research since the discovery of the Van Allen radiation belts. Contributing to the value of the mission is the fact that the results of the various experiments are complementary; they also build on and extend previous findings of ground-based astronomy.

Useful data on particles, fields, and micrometeorites were collected during the voyage to Mars. Additional information was gathered after the fly-by, and more may be forthcoming when the spacecraft is once again fairly close to Earth. The major contributions, however, are the observations in the vicinity of Mars. Among the most important are the photographs (*Science*, 6 August). These show that, unlike Earth, Mars resembles the moon in topography. There are many craters, but there is no evidence of mountain chains.

Experiments on particles and fields reported in this issue show other major differences between the two planets. The magnetic field of Mars is not more than 1/1000 that of Earth, and the Red Planet has no radiation belt. An occultation experiment gives independent evidence that the atmosphere of Mars is tenuous and unlike that of Earth. A micrometeorite study shows that interplanetary dust is more abundant in the vicinity of Mars than near Earth.

The evidence from the photographs, the absence of a sizable magnetic field, and the character of the atmosphere all support the view that the history of Mars has been unlike that of Earth.

An example of a close relation between Earth-based findings and findings from Mariner is the estimate of the composition and density of the Martian atmosphere. Astronomers have known for some time that the atmosphere of Mars is thin and that it contains CO_2. Recently the estimates have been sharpened. Measures of infrared radiation indicate that the total pressure at the Martian surface is 11 millibars, of which about half is CO_2 (0.28 mole per square centimeter). The Mariner IV occultation experiment determined changes in radio signals from the spacecraft caused by passage through the atmosphere and the ionosphere of Mars. Preliminary interpretation of the data provides an estimate of the scale height of the atmosphere (~9 km) and its density. The pressure at the surface of Mars as estimated from the data (about 5 or 6 mb) is lower than estimates obtained in ground-based studies. This disagreement is not serious, and the discrepancy will probably diminish on further analysis. The important fact is that two very different kinds of measurements give essentially the same result. Half or more of the atmosphere of Mars is CO_2, and the total number of molecules per unit area is about 1/100 the number in the Earth's atmosphere.

The contrast between Earth and Mars can be stated in another way by listing the amounts per unit area of three volatile substances that have appeared at the surface of the planets in the past or are now present. For Earth the values are: H_2O, 3.2×10^5 g; CO_2, 1.8×10^4 g; N_2, 8×10^2 g. The corresponding values for Mars are: H_2O, ~0.01 g; CO_2, ~12 g; N_2, <10 g. The numbers are not strictly comparable, for most of the CO_2 that has reached the surface of the Earth is now incorporated in sedimentary rocks. Probably most of the H_2O that has appeared on Mars has been lost, the hydrogen having escaped and the oxygen having been consumed or lost. Nitrogen has not been detected on the planet, and the value given is probably an upper limit, derived from the pressure effect it exerts on CO_2.

The success of Mariner IV represents a superb engineering achievement by the Jet Propulsion Laboratory. The accomplishment required the proper functioning of 134,000 parts after 7 months in space. The magnitude of the success is highlighted by the failure of others to attain the goal. The Russians, who have some first-class engineering talent, have not succeeded in their dozen or so attempts at attaining close-in data from Mars or Venus.—PHILIP H. ABELSON

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