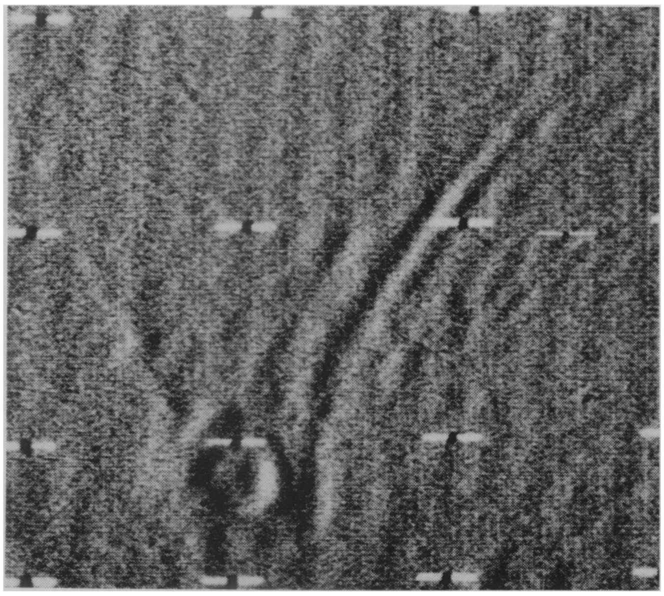
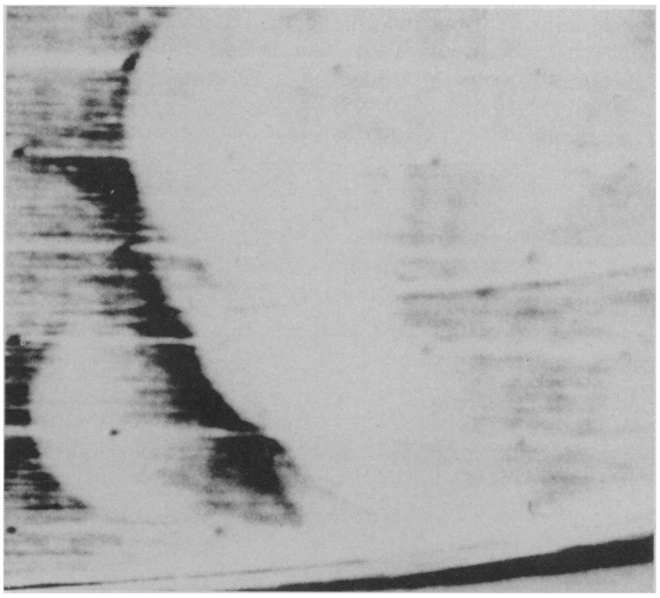


JPL

Turbulence patterns or dunes streak out from Arsia Silva.



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Portion of Mars' south polar area viewed by Mariner 9.

An orbital view of a Martian dust storm

Mariner 9 ended its 167-day journey from earth to Mars last weekend and became the first manmade satellite to orbit another planet. It was greeted by an unearthly phenomenon—a global dust storm that had originated in the southern hemisphere of Mars in late September and since has spread over the entire planet—obscuring the surface to its earthly visitor (SN: 10/9/71, p. 245). "The storm has done great things," says Harold Masursky of the U.S. Geological Survey. "It has wiped out the normal conditions on the planet."

Scientists were baffled by this global meteorological phenomenon. Is the storm caused by wind and, if so, is the wind still active? How high is the dust in the atmosphere? What is the wind pattern on a global scale? While there was no agreement on the answers, there was accord with Masursky who said, "Mars is putting on the most spectacular show it has ever staged."

Although the dust storm was a disappointment to the press corps assembled at Pasadena to view the first orbital photographs of the Martian surface, the scientists tended to be pleased at the opportunity to observe weather conditions on another planet. Functioning perfectly in an orbit of 1,395 by 17,800 kilometers and with a designed operating lifetime of at least three months, Mariner 9 seemed likely to have ample time to view the surface after the storm dies down.

Only two of the first 64 photographs transmitted by Mariner 9 showed any possible surface features, and scientists at California Institute of Technology's Jet Propulsion Laboratory in Pasadena were not in agreement about them. The first glimpse of a possible surface feature was from a pre-orbit photograph. The area was one of several "bright spots" on Mars that seemed to be conducive to the development of recurrent stationary clouds. The recurrence of these features—in this case the "W" shaped cloud observed frequently from earth—led to the belief that the bright areas are elevated. "What the storm may have done," said Masursky, "is wipe out the clouds, revealing the high terrain below." The photo showed three dark areas that appeared to be craters. Extending from the southern-most crater area were streaks that appeared to be sand dunes extending some 500 to 1,000 kilometers out from the crater. The three craters could be Ascraeus Lacus, Pavonis Lacus and Arsia Silva, but there was little agreement about that also. Nor were scientists certain they were seeing the surface. "We could be seeing atmospheric effects and the dark hole could be an opening in the clouds," said Masursky.

The second photo was an orbital shot of a region near the south polar cap. While the two television cameras weren't having much luck, the ultraviolet spectrometer, infrared interferometer spectrometer and the infrared radiometer were yielding some results. The ultraviolet instrument will in time transmit data that will record temporal changes in the vertical distribution of components in the atmosphere of Mars. In the first few days in orbit the instrument confirmed the presence of ionized CO_2 molecules decreasing in density toward the surface of Mars. It detected carbon monoxide and atomic oxygen.

The infrared radiometer measures the surface temperature of Mars. "We have had a few minor surprises," Ellis D. Miner of JPL said this week after looking at data from the first two orbits. The first orbital pass showed a slight temperature increase of 1.5 degrees C. in an area of the south polar cap. The second orbit revealed an even greater surprise—a temperature spike of 8 degrees C. The "hot spot," as yet unexplained, was in the same general region pictured in the high terrain photograph —about 10 degrees latitude below the Martian equator. "We are not able to locate anything on the maps that would indicate anything out of the ordinary visually in this region," said Miner. He added that the area has "warmed up to the temperature of the Antarctic." (The mean surface temperature of Mars is minus 57 degrees C. in this area.)

The hot spot could be the result of an internal source of heat such as volcanic activity, or it could indicate a hole in the cloud cover exposing a high land area that might reflect residual heat from the sun.

The infrared spectroscopy will supply data for determinations of atmospheric pressure and temperature at the surface, temperature distribution with height and chemical composition of the atmosphere and the surface.

But the dust storm still captured most of the early interest. How long will the dust be around? No one could tell. If the dust is mixed uniformly in the Martian atmosphere, it would take as long to settle as would dust in the earth's atmosphere. The reason is that although the earth's atmosphere is denser than Mars', the Martian atmosphere is composed largely of carbon dioxide, which is more viscous.

In spite of the dust problem, scientists at JPL remained excited about the three-month Martian expedition. "We will find out whether Mars is coming to life or is dead," said Bruce C. Murray of Caltech. "It will be a cultural experience for the whole world to view." Mariner 9 will not be able to detect life but will be able to relay data about surface and atmospheric conditions that could be conducive to life. "Even if no life is found," said Masursky, "we are looking at a planet that has followed a different sequence of evolution than that of the earth."

Two Russian spacecraft, Mars 2 and 3, are also on the way to the planet and will encounter it between Dec. 1 and 3. Although there has been no official Russian announcement, Western observers believe that at least one of the two craft will attempt to descend through the atmosphere of Mars. They do not expect that the Russian craft will carry instruments to detect life.

The first telex message sending Mariner 9 data from Pasadena to scientists in the Soviet Union was sent this week. □

New optimism for controlled fusion

"The controlled thermonuclear fusion program in this country may be at a turning point." Thus Rep. Melvin Price (D-Ill.) summed up two days of hearings last week into the current status of that branch of physical research before his Subcommittee on Radiation, Research and Development of the Joint Congressional Committee on Atomic Energy.

The hearings exhibited a general optimism among the scientists working on the program—a sharp contrast to the attitudes of a few years ago. The change of mood began about two years ago; now it has reached the point where almost everyone agrees that, given the money, the scientific feasibility of a thermonuclear fusion reactor can be demonstrated by the end of this decade.

The new optimism is based on experimental and theoretical developments of the last few years, which represent a significant change in the state of the science. The committeemen cross-questioned the scientists rather closely on this point, knowing, as they do, that fusion was the subject of an early enthusiasm that later gave way to years of frustratingly slow achievement.

What has happened now is that theory and experiment have come together and have at last shown promise of achieving what the original plasma theorists predicted. The original theory, called classical plasma theory, predicted that a plasma could be confined in a magnetic trap, and that the rate of loss of plasma particles by diffusion out of the magnetic field would be low enough to allow a steady, energy-producing fusion reaction to go on.

Experiments repeatedly failed to confirm the prediction, and plasma physicists settled down to long years of empirical trial and error in which the work of those pursuing one approach often seemed to have little connection to the work of others. "There was so little relation between what we saw and what we expected to see that it didn't matter whether people talked to each other," Melvin B. Gottlieb of Princeton University told the subcommittee. "Now there seems to be a close relationship."

In the last few years returns from various kinds of plasma confinement experiments have shown that diffusion rates approaching or equaling the classical prediction can be achieved. Especially exciting were the results from a toroidal device called tokamak that was developed in the Soviet Union. The first American tokamak was built at Princeton by converting another toroidal device, the model C stellarator. Experiments with the Princeton tokamak appear to have answered the question why the experimental breakthroughs have occurred. The increased size of the plasma in the device seems to be the criterion: Large plasmas can approach classical confinement; small ones cannot. A theory to explain the situation, called the neoclassical theory has developed.

With the experimental achievement and the theory to explain it, the plasma physicists are convinced that their effort is ready to take off. Their optimism comes through even the careful qualifications and warnings of possible future surprises that they did not fail to insert into their testimony.

The people at the Princeton Plasma Physics Laboratory want to start building a new large tokamak with a plasma 45 centimeters in diameter (two or three times the size of most present tokamaks). They envision this as an intermediate step to an experiment that will demonstrate scientific feasibility. (The definition of scientific feasibility is a plasma that produces a sustained fusion reaction that yields more energy than has to be put in to get it going.)

Even more optimistic is Tihiro Ohkawa of Gulf General Atomic, who is about to begin experiments with a device called Doublet II, which is a variation on a tokamak. If Doublet II works, Ohkawa wants to build Doublet III, which he thinks could demonstrate scientific feasibility in a few years.

It will take money. In Gottlieb's words the U.S. fusion program has been "starved for money." In order to take up tokamaks, for instance, the U.S. program had to drop other approaches, particularly stellarators.

Roy W. Gould, assistant director (for controlled thermonuclear research) of the division of research of the Atomic Energy Commission estimates that a modest program would require doubling the current budget of $32 million to $65 million by fiscal year 1975 and more gradual increases to reach $89 million by fiscal 1980. A crash program, he figures, would involve doubling and redoubling to $143 million in 1974 and more increases to $237 million in 1980.

The committeemen were generally sympathetic to the idea of giving the program more money but dubious about where they were going to get it in a time of economic depression. But Sen. Stuart Symington (D-Mo.) pointed out that the amounts are small compared with the more than $7 billion the Department of Defense gets for military research and development. We spend so much on Vietnam, he said, we could put a little more on this program.