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.