How Important a Planet is Venus?

NEW knowledge about the planets tends to come in quantum jumps as the data from each new planetary probe are analysed. The two missions to Mars in 1969 are a case in point, and the ramifications of the beautifully detailed photographs and data obtained on that occasion are now being elucidated. It is still too early to say, however, whether last month's visit to Venus by the Soviet spacecraft Venera 7 will bring about a similar substantial increase in what is known about that planet. Fortunately the signs are that at least some data have been obtained, but whether they will significantly add to the handful of bench marks that have been drawn up during the past year or two will in the way of these things probably not be known for a while.

Surely Mars is in any case a more worthwhile target, particularly while there is a chance of finding some kind of life there? That seems to be the mood in the United States where people are looking forward to the two Mariners which are to be placed into orbit around Mars in November this year, and to the Viking soft landing project in 1975. To some extent, however, the concentration on Mars goes against the grain in that the Space Science Board of the National Academy of Sciences has been backing a broader approach and missions to as many different planets as possible (although it is probably true that if financial problems meant that a choice had to be made there would be many who would prefer to concentrate on Jupiter). As to the question of life on Mars, it is clearly going to be expensive to prove to everybody's satisfaction that life is absent, and not existing deep below the surface or hidden in some crevice.

Has Venus, then, been wrongly ignored? That is the feeling conveyed by the report *Venus, Strategy for Exploration*, prepared by a panel set up by the Space Science Board in cooperation with the Lunar and Planetary Missions Board of NASA, and published by the National Academy of Sciences. Whether anything can be done at this stage to correct the imbalance that the panel believes has crept into the American strategy for planetary exploration is a different matter, but the panel recommends a programme of comparatively simple probes that would cost $100 million for the first three missions, falling to $20–25 million for each succeeding probe. A large part of the argument of the panel is that the study of Venus will broaden the horizons of meteorologists, and it was obviously a good choice to have a planetary meteorologist, Professor Richard M. Goody of Harvard, as the chairman.

Basically the reason for becoming enthusiastic about Venus is that it is in the opposite boundary condition to the thin atmosphere and almost cloudless skies of Mars. Conditions in the terrestrial atmosphere are in an intermediate—and more complicated—state, and the trophy which everybody should be after is a general theory accounting for all three atmospheres. In simple terms the opposites represented by Mars and Venus are that the atmosphere of Mars is almost in radiative equilibrium and the dynamics of the atmosphere have little effect on the temperature distribution, whereas on Venus the temperature distribution seems to be strongly influenced by the dynamics of the atmosphere as a result of the effect of the clouds and thick atmosphere on solar radiation. Presumably the greenhouse effect of the clouds is responsible for the surface temperature of 700 K. In fact, most of the solar radiation is being absorbed in the upper layers of the cloud cover in much the same way as the terrestrial oceans absorb most of the radiation near the surface, although nobody seems to have made anything from this interesting parallel. So far, however, there has been barely enough information coming from the Mariner 5 flyby and the atmospheric probes of Venera 4, 5 and 6 to make a start on a theory of the atmosphere.

What the Venus panel would like to have—and which Venera 7 obviously cannot provide—is a series of simultaneous profiles of the atmosphere on the day and night sides and at several latitudes. It would also be valuable to have a system of Doppler tracking of the probe as it sinks through the atmosphere to give an indication of the wind vector. A harder problem is to determine the composition and particle sizes in the clouds, both still unknown, although the atmosphere seems to be chiefly carbon dioxide like Mars. The presence of the carbon dioxide is itself a puzzle, first because it would reasonably be expected to be dissociated by the solar ultraviolet radiation into carbon monoxide and oxygen atoms, yet these species only appear to be present in traces. But the burning question is what has happened to the water which on Earth sees to it that carbon is held in rocks in calcium carbonate, but whose absence on Venus seems to have allowed the formation of a carbon dioxide atmosphere. Was there no water on Venus in the first place, or has it been lost, possibly by dissociation followed by the escape of hydrogen atoms? One way of throwing some light on this question is to examine the ratio of hydrogen to deuterium in the atmosphere of Venus, because the remaining water might well be enriched in the heavier isotope which would escape less readily into space.

Those who are interested in the internal constitution of planets will find Venus less worthwhile a target, however, because of the problem of devising instruments that will work at the pressures and temperatures encountered at the surface. Apart from the difficulties of shielding equipment from the environment, an instrument such as the alpha particle backscatter experiment carried on the Surveyor softlanders to give the first chemical analysis of the lunar surface is not going to work on Venus because of the short range of alpha particles in the dense atmosphere. More likely a system based on nuclear gamma radiation will have to be devised. And most people will consider a robust seismometer to be an essential part of any landing on a planet. Just as worthwhile at present and considerably cheaper is to study the geophysics of Venus from an orbiter, by means of magnetic field measurements, radar measurements of surface elevations to compare with the radar brightness maps taken from the Earth, and determinations of the gravitational field. At the same time there is a lot that could be learnt from orbit about the ionosphere of Venus, and the way in which the planet interacts with the solar wind—what effect on the planet does the penetration of the solar wind to 500 km from the surface have, for example? Under the circumstances it would be a shame if the continuation of the exploration of Venus was left too long.