Cometary exploration

Plans for future space missions

from Alan Johnstone

IT may seem premature to plan more space missions to comets before any of the group of five now scheduled to meet Halley's comet in 1986 have even left the ground, but such is the interest in this comet and so long is the time required to prepare a new space probe, that planning for the next generation of spacecraft is already underway.

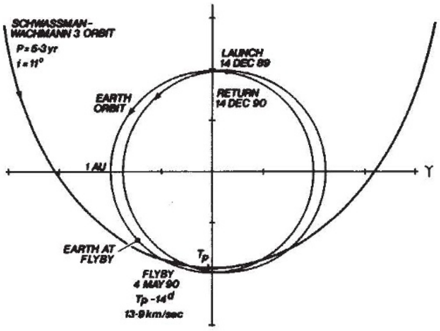
All the missions planned so far are flyby ones, that is, they will make one pass through the coma at the high velocity of 67 km s^{-1}. Giotto, the European Space Agency's (ESA) mission, which will be aimed closer to the nucleus than any of the two Russian and two Japanese spacecraft, will collect data on the composition of the comet over only four hours. These data will be collected by automatic instruments, set up beforehand to operate in the conditions believed to exist near the nucleus. There will be no opportunity to make adjustments during the flight. Despite the difficulties, a flyby mission is the proper first step in cometary exploration and the first measurements actually made within the coma of a comet, rather than on the radiation coming from it, will revolutionize cometary science.

A consensus now exists among cometary physicists about the form that the next steps in cometary exploration should take. First priority is a rendezvous mission in which the spacecraft is manoeuvered to be in the same orbit around the Sun as the comet. This will enable the comet to be studied as it passes from several astronomical units into perihelion and out again. Furthermore, as the spacecraft observes the development of the coma, it will be able to move at leisure through all the important regions. The difficulties are that such a programme requires advanced propulsion systems and is limited to the study of an unimpressive group of comets — those deflected by the gravitational effect of Jupiter into orbits which keep them in the inner Solar System. Nonetheless, one is being planned for the mid 1990s as a joint US–FRG venture.

For those interested in the composition of the comet and the origin of comets and the Solar System, the ultimate aim is to bring back to Earth a sample of cometary material — ideally, a piece of the nucleus — to be analysed in the laboratory using a formidable array of sophisticated techniques (Niehoff, J. *Comet Sample Return Mission Techniques*, Eur. planet. Sci. Symp., Heidelberg, April 1984). This kind of mission involves all the difficulties of a rendezvous mission, with the additional problems of acquiring and returning a solid sample. It will not be undertaken this century.

A much less difficult mission is to collect coma dust and a gas sample. The samples are collected on special plates carried on a simple flyby spacecraft which then returns to the Earth in its natural orbit and ejects the samples in a re-entry probe to be recovered as it descends through the atmosphere on a parachute. Engineers and scientists from NASA and ESA are currently studying the feasibility of a mission using a second model of the Giotto spacecraft. Its dust shield would be modified to carry the collectors, consisting of a number of cells or compartments covered by a thin diaphragm. Dust grains vaporize when they strike the diaphragm and the resulting gas condenses on the specially coated walls of the cell from where it can be recovered and studied in laboratories on the ground. Plane coated surfaces would be used to collect coma gas molecules. It is even possible to collect dust particles nearly intact by decelerating them slowly in a foam material that does not overheat the particle. Although some of the outer layers are removed in the process, 80 per cent of the particle can be recovered and its mineralogy studied. After encounter, the collectors would be retracted and stowed within a re-entry capsule mounted within the space now occupied by the rocket motor. This rocket injects the spacecraft into an orbit around the Sun; the need for it in Giotta 2 could be removed by using an appropriate launch vehicle. The rest of the instrumentation on Giotto would remain the same and would be used to study a second comet.

Several targets have been identified in the years 1989–1994. For example, a probe launched on 14 December 1989 would encounter Comet Schwassmann — Wachmann 3 on 4 May 1990 and return to the Earth on 14 December 1990 (see the figure).



The trajectory profile for Schwassman-Wachmann 3 coma sample return. *P*, period; *i*, inclination; T_p, time of perihelion.

The provision of the spacecraft by ESA would be much less expensive than usual since the spacecraft would be made to an existing proven design as a continuation of the present project. NASA would provide the re-entry probe and the launcher. Thus an exciting new mission could be achieved quickly, at a fraction of the cost of developing a planetary mission from scratch. □

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Diabetes

On the track of viruses

from Abner Louis Notkins

THERE are two major forms of diabetes mellitus: the insulin-dependent (IDDM) type, often referred to as juvenile diabetes, and the noninsulin-dependent (NIDDM) type, also known as maturity-onset diabetes[1]. IDDM is caused by destruction of the insulin-producing β cells in the pancreas which results in hypo-insulinaemia and hyperglycaemia. The pathogenesis of NIDDM is less well understood. In this form of diabetes, there is little evidence of β-cell destruction and insulin levels in the blood are generally within the normal range. There is evidence, however, that in some cases the functional capacity of β cells, as measured by glucose-stimulated insulin release and/or the capacity of peripheral tissues to metabolize glucose, is impaired. It has been known for several years that in experimental animals, the destruction of β cells by acute viral infections can cause IDDM[1,2]. Now, in a recent issue of *Science*, Michael Oldstone and his colleagues show that in mice, a non-destructive but persistent viral infection of β cells can result in a condition resembling NIDDM[3].

Extensive studies over the last decade, especially with encephalomyocarditis (EMC) virus, have shown that the development of virus-induced IDDM in mice depends on the genetic background of the host (only certain inbred strains of mice develop virus-induced diabetes) and the genetic make-up of the virus[1,2]. The severity of the disease is directly related to the number of β cells destroyed by the infection and, in some cases, several insults are required to produce sufficient β-cell damage to result in clinically apparent diabetes. Variants of Coxsackie B viruses, Mengo virus and reoviruses also have been shown to damage β cells and produce diabetes. In humans, several lines of evidence including sero-epidemiological data, histological surveys of human