An artist's impression of the Giotto spacecraft approaching Halley's comet.

Close encounter with a comet — the Parkes link

With all of the Halley hype and hoo-ha around at the moment, you could well be forgiven for sleeping through the heavenly body's appearance in our skies. Perhaps knowing that Australia is playing a key role in checking out the stuff Halley is made of will help you stay awake.

The European Space Agency (ESA) launched the Giotto space probe in mid 1985 to greet comet Halley as it hurtles past the sun. The measurements that Giotto makes in the comet's atmosphere will go straight to the radiotelescope at the CSIRO Australian National Radio Astronomy Observatory near Parkes, N.S.W. The climax of the Giotto mission will be a fast flyby of Halley on March 14, 4 weeks after the comet's closest approach to the sun.

Comets and all that

Most astronomers believe that comets — and several billion of them accompany our sun on its path through the galaxy — were formed from the same clouds of gas and dust that formed the planets of our solar system. But whereas millions of years of change have obscured the history of the earth and its planetary neighbours, the comets have spent most of their time in deep freeze far beyond the orbit of Pluto. The only changes that comets like Halley ever experience are ionizations of their outer layers during their periodic close approaches to the sun.

A close look at Halley should tell us a lot about the nature and composition of the ancient solar nebula, as well as about the formation and early history of the solar system.

Halley's comet can be thought of as a huge snowball, containing frozen gases and dust as well as water, moving in a long elliptical orbit that takes it very near the sun. As it approaches the sun, the frozen gases of the comet's 'nucleus' sublime directly back into gaseous form and expand outwards, carrying the particles that form a halo or coma. Winds and radiation from the sun blow the coma's hot electrically charged gases, called plasma, into a fluorescent tail. Halley's is one of a group of comets that have two tails — a dust tail and a plasma one.

Exactly what's in the cometary nucleus and dust remains to be determined. During the 1910 passage of Halley, astronomers using early spectroscopes detected a range of molecules, and the current best guess is that comets contain hydrogen cyanide, methyl cyanide, carbon monoxide, sodium, nitrogen, methane, ammonia, and of course water. One theory proposes that comets were a major source of organic materials in the atmosphere of the planets. The Giotto probe will give us the closest picture yet of a cometary nucleus, and perhaps provide clues as to whether cometary seeding really played a role in the development of life on earth.

Giotto, Parkes, and Carnarvon

The probe, built by British Aerospace, is a 3-m-high cylinder with a diameter of 1·8 m. It will encounter Halley's comet about 150 million km from the earth. Giotto will come as close as 500 km to the comet's nucleus, beginning its major data-gathering activities 4 hours before it does so. It is not expected to survive this encounter, so all of the information it collects during its approach has to be transmitted directly to the earth.

The Parkes telescope is the facility that will receive these immensely important messages from space. To enable the telescope to perform this task, CSIRO (under

This shot of the comet was taken on 19 May 1910. A modern image display processor has added colour and brought out detail.

contract to ESA), has installed new equipment to upgrade its control, drive, and guidance systems, and has resurfaced a further portion of the 'dish'. After they receive the information from Giotto, the team at Parkes will relay it — via commercial cable and satellite links — to ESA's comet-watch base in Darmstadt, West Germany.

Australia has had another central role to play in the Giotto exercise. The Overseas Telecommunications Commission's 15-m tracking dish at Carnarvon, 900 km north of Perth, has been relaying command information to Giotto — such as minor orbit corrections and the switching on of instrument packages on board the spacecraft. The minor orbit corrections needed will be determined from information transmitted by Japan's Planet A and Russia's Vega spacecraft, which are making more distant flybys before Giotto encounters the comet.

Instruments on board the ESA probe include a colour camera, a photopolarimeter, dust detectors, ion and mass spectrometers, a magnetometer, and equipment for several plasma-detection experiments. The photographs sent back will help scientists to determine the size, mass, and rotation characteristics of the nucleus. The photopolarimeter will measure the polarization of light reflected from cometary dust particles, giving information about their size and density. The magnetometer will analyse the magnetic field within the coma.

The plasma experiments have been designed to collect information about the shock wave caused by the interaction of the sun's flow of charged particles and Halley's coma. Data from NASA's International Cometary Explorer (ICE) spacecraft, which crossed the path of another comet last year, indicated that no distinct 'bow shock' — much as the earth shows as it ploughs through solar winds — occurred around the comet.

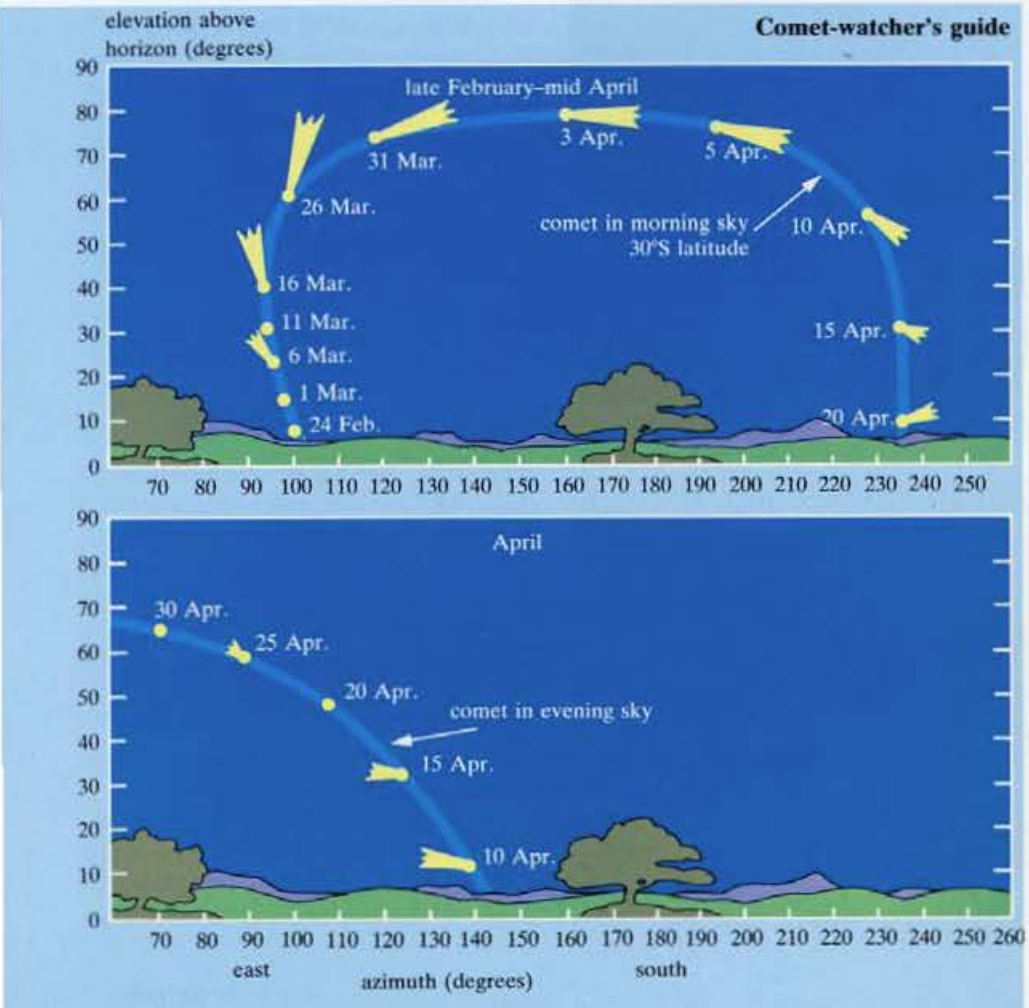
The Parkes telescope will receive these immensely important messages from space.

Most of Giotto's instruments are mounted behind a double-layer dust shield made of a thin aluminium sheet positioned in front of a composite shield of Kevlar foam — a lightweight material used in bullet-proof vests and battleship armour. The sensors of the instruments protrude from the side of the spacecraft and point towards the comet past the dust shield.

The comet environment of dense dust particles, combined with the probe's high speed — 68 km per second — has made dust impact a major design consideration. At this speed, dust particles with masses one-tenth of a gram could penetrate the spacecraft's structure. Although the shield should protect Giotto during its 4-hour 'encounter', scientists don't expect the

The path of Halley's comet, as viewed from the Southern Hemisphere, during its closest approach to the earth.

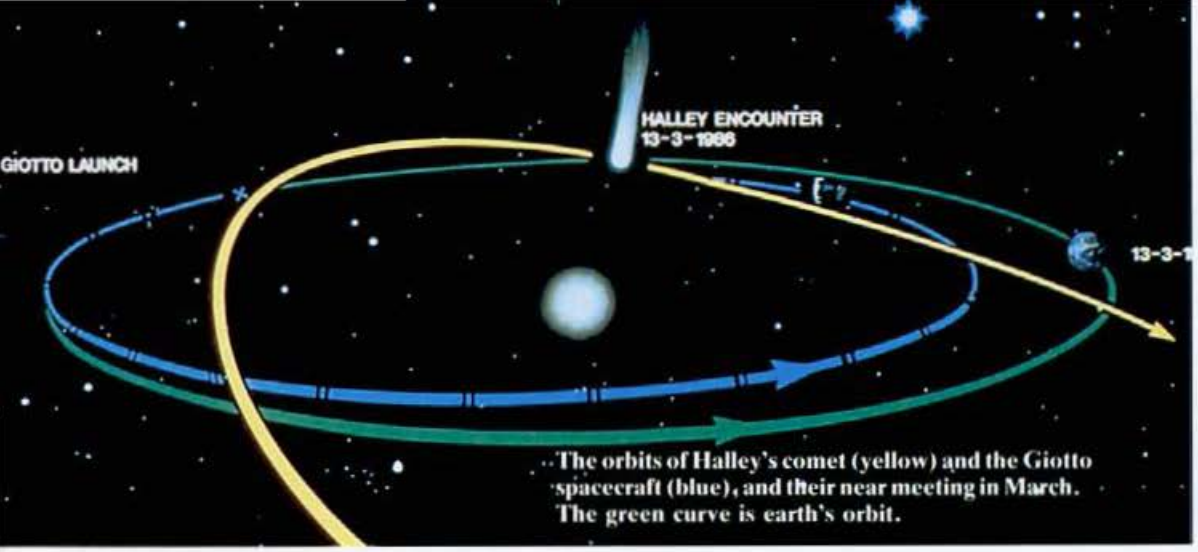
Comet-watcher's guide



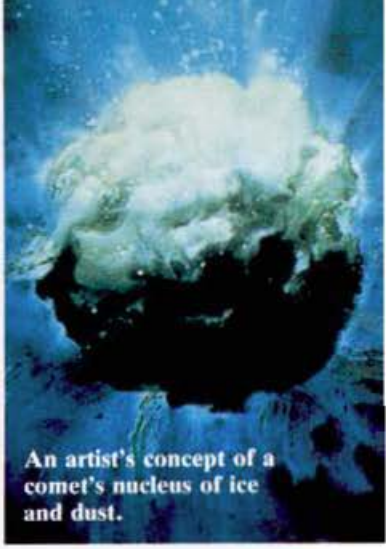
Where to look

As you may already know, this appearance of Halley's comet will be the least spectacular of any during the past 2000 years. To optimize your chances of a sighting, get away from city lights, pollution, haze, or dust.

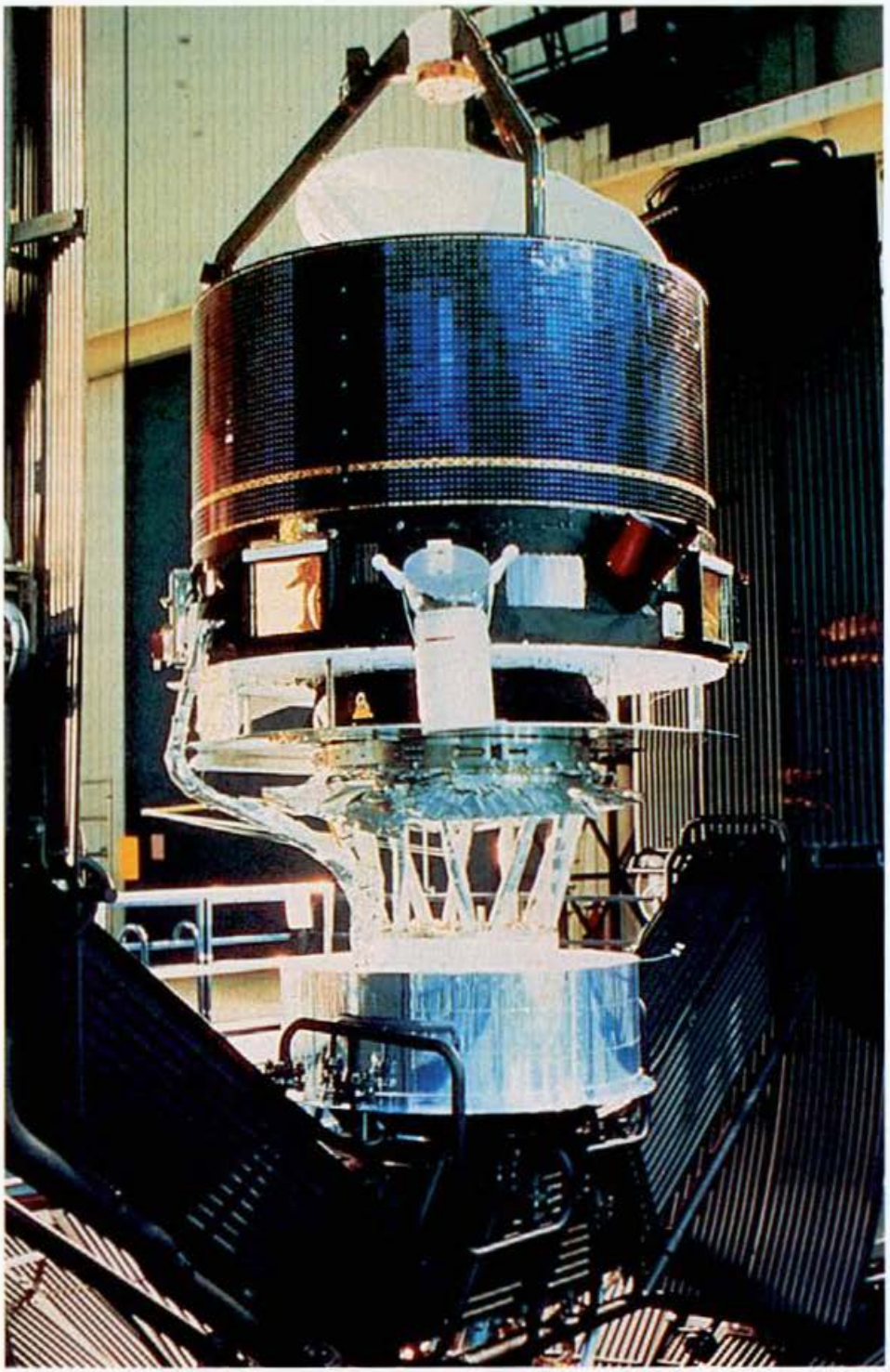
In March, the comet will become visible low in the eastern sky about an hour and a half before sunrise. The comet moves closest to the earth on April 10, and in early April will be visible all night after rising in the south-east soon after dark. At about 4 a.m. on April 5, the comet will be high in the sky and slightly to the south. The best views will be from midnight onward. Field glasses or the naked eye will give best results — telescopes have too high a magnification for such a 'large' object as a comet. Happy viewing!



The orbits of Halley's comet (yellow) and the Giotto spacecraft (blue), and their near meeting in March. The green curve is earth's orbit.



An artist's concept of a comet's nucleus of ice and dust.



The Giotto spacecraft in a testing facility.

protection to withstand any further onslaught.

Earth-based observations

Back on earth, Australian astronomers based at Parkes will be carrying out experiments of their own. Since November 1985 they have been observing radio emissions from the comet's hydroxyl molecules — formed when the sun's ultraviolet light irradiates water molecules. Hydroxyl radicals can either absorb radiation from the sun or amplify it, acting as natural masers. This generates a pattern of alternating absorption or emission lines, which will provide information about the nucleus composition, including the importance of water as a major constituent.

To co-ordinate observations on the ground, astronomers have formed the International Halley Watch. Specialists will supervise studies of seven different areas, based mainly on the wavelengths of the radiations used in each study. Professor Ron Brown and Dr Peter Godfrey, of the Department of Chemistry at Monash University in Melbourne, are Australia's representatives on the co-ordinating committees.

Mary Lou Considine

More about the topic

Halley's comet, 1985-86. R.J. Lawrence. *CSIRO Information Service Sheet* No. 1–41, July 1984.

The Giotto project — a fast flyby of Halley's comet. R. Reinhard. *ESA Journal*, 1981 **5**, 273–85.

Call Halley's comet

For a weekly update on the comet and associated phenomena, dial Sydney or Brisbane 11622 or Melbourne 11613. The weekly scripts for this joint Telecom–CSIRO community service are prepared by Dr Ray Norris of the CSIRO Division of Radiophysics.