

Halley's comet**Prospects for Giotto and Halley***from M.K. Wallis*

AT the final pre-launch preview*, scientists involved in the Giotto mission to Halley's comet concluded that the risk to the spacecraft from dust particle impacts (see *Nature* 303, 659; 1983 and 305, 756; 1983; *ESA J.* 7, 15; 1983; *Earth, Moon Planets* 30, 31; 1984) is considerably less than had been feared.

Initial pessimism had centred on the likelihood of impacts that would cause a deviation of Giotto's spin axis in excess of 1°, when radio contact would be lost. Although milligramme and smaller-sized grains impacting the protective shield will contribute to the deviation, it is now agreed that the original pessimism was based on an over-weighting of the rather improbable grains exceeding 0.1 g, which might anyway smash through the rear shield and destroy instrumentation.

Predictions of survival are based on predictions of the density and size-distribution of dust particles. The probability of survival against 1° perturbations is now given as around 90 per cent on the nominal dust model for a 500 km flyby distance, although calculations need extending to give a secure guide for future targeting decisions.

Much scientific effort has gone into elaborating models of the comet's dust coma; rather than assuming instantaneous formation, it is now agreed that dust grains can reside in the coma for weeks or even months, forming into anisotropic structures purely because of the comet's motion around the Sun. Model calculations at the NASA-Jet Propulsion Laboratory (JPL) have been extended to encompass long-lived dust grains and are now in agreement with an alternative analysis by ESOC scientists (Fertig, J. & Schwehm, G.H. *ESA Bull.* 38, 36; 1984).

There has been concern about much higher dust densities in jet-like regions. JPL scientists (Sekanina, Z. & Larson, S.M., *Astr. J.* 89, 1408; 1984) have applied digital image-enhancement techniques to photographs of comet Halley's 1910 apparition, and infer enhanced densities, some 10-100 times the mean. It is now accepted, however, that these would be of submicron size (like cigarette smoke) and present a desirable target rather than a threat to the spacecraft's integrity. Study of the jet phenomenon might, alternatively, indicate where to expect the dangerous, slowly-moving, millimetre-sized grains.

Originally, the mission was scheduled to terminate one hour after closest approach, supposing that the spacecraft is unlikely to survive. But there was pressure from experimenters at the meeting to retain trans-

mission options for two days on the outward flight through the extensive gas coma.

The meeting heard that the Pathfinder concept agreed with the Soviet Space Agency is going ahead; data from the Soviet VEGA spacecraft will be used to cut down the error in targeting. If the two VEGAs are tracked by very long baseline radio-interferometry, the error should be under 100 km. Supplementary ground-based astrometry is also to be investigated.

The reserve of one month in the original schedule has now been used up, with final instrument acceptance checks due in late March. No significant problems have arisen on subsystems or experiments during the system test programme, although the

spacecraft as a whole is hotter than predicted, requiring modifications to radiating surfaces. Assembly and final testing of the television camera is running late, so installation and checking procedures have been reorganized around it. One advantageous change to the original schedule gives scientists the option of integrating fully-calibrated versions of their experiments just before delivery of the spacecraft.

The planned launch campaign is due to commence at the beginning of May 1985 with an expected launch date of 2 July 1985 on an Ariane 1 vehicle from the European launch site at Kourou, French Guiana. The optimistic hopes of securing data on the inner coma and pictures of the nucleus from a few hundred kilometres seem likely to be achieved on the basis of this review. □

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Chemical evolution**Origin of biomolecular chirality***from Stephen Mason*

THEORIES accounting for the ubiquity of the L-amino acids and the D-sugars in the biochemistry of living organisms centre on mechanisms for the selection of enantiomers of one hand from the heterochiral mixture of a racemic substrate, and for the propagation of optically pure homochiral products. Surprised to learn, in 1953, that the origin of biomolecular handedness still appeared to be problematic, Frank proposed a homogeneous chemical kinetic mechanism for an open flow-reactor system¹. The mechanism contained no internal bias, and the dominance of the L-amino acids and the D-sugars in the natural products, rather than their respective enantiomers, seemed to be wholly a matter of chance. By extending the mechanism and incorporating a recently evaluated internal bias, Kondepudi and Nelson² now define the particular conditions under which a small electroweak advantage factor for the L-series of amino acids and polypeptides³ leads to a determinate choice in the evolution of homochiral biomolecules from an achiral or racemic substrate.

Frank's model avoided the direct intervention of external agencies, such as a chiral field or panspermatic celestial seeding, and the various heterogeneous mechanisms advocated in the grand debate on the subject in the correspondence columns of *Nature* during 1898 following F.R. Japp's paper on "Stereochemistry and Vitalism"⁴. Ironically, that correspondence ignored the 1884 conjecture of Pasteur that a dissymmetric force pervades the physical world, extending even to the crystallization dish used for the separation

of enantiomers. The discovery, in 1956, of the non-conservation of mirror-image symmetry in the weak nuclear interaction supported Pasteur's surmise, and the subsequent unification with electromagnetism has allowed the characterization of both the sign and the magnitude of the universal chiral electroweak interaction. The sign is in accord with the observed products of natural selection. The L-amino acids and the L-polypeptides are more stable than their D-enantiomers. But the advantage ratio of the electroweak enantiomeric energy difference (ΔE_{ew}) to the thermal energy (kT) at ambient temperature is only about 10^{-17} (ref.3), too small according to one school of thought⁵ to affect the outcome of biochemical evolution.

Frank envisaged an open reactor system with a continuous input of an achiral substrate from which both enantiomers, L and D, are formed (see figure). Each of the optical isomers autocatalyses its own production and competitively inhibits propagation of its enantiomer. In general, the dynamic generation of a racemic product is metastable and subject to a bifurcation catastrophe. Chance fluctuations sooner or later trigger a kinetic switch to one of the homochiral reaction channels, producing either the L-isomer or the D-enantiomer. Which is produced, in the absence of an internal bias or an external perturbation, depends on the sign of the chance fluctuation¹.

The general solution to the kinetic relationships of the extended mechanism is shown to be a cubic equation in the enantiomeric excess of the handed products, ($\alpha/\beta = ([L] - [D])/([L] + [D])$), where [L]

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