The recovery of Halley's Comet

from David W. Hughes

AMERICAN and European astronomers have been competing with each other to be the first to sight Halley's Comet. It was last seen at the end of May 1911, heading away from the Sun and passing below the orbit of Jupiter. It reached aphelion in 1948 and has been racing back towards the inner Solar System ever since.

The Americans have won. *International Astronomical Union Circular,* number 3737, reported that D. Jewitt, G. Danielson, J. Gunn, J. Westphal, D. Schneider, A. Dressler, M. Schmidt and B. Zimmerman recovered the comet on the night of 16 October 1982. They used a charge-coupled device at the prime focus of the 5.1 m (200 inches) Hale telescope at the Palomar Observatory, California. Charge-coupled devices are much more sensitive than photographic plates and with the 5.1 m telescope can detect objects fainter than 25th magnitude, some 50 times fainter than the photographic limit. Five 8-min exposures were taken through a broad-band blue filter. An object was detected near the expected position of the comet, moving in the expected direction at the expected velocity. It had a magnitude of 24.3 ± 0.2 (a change of unity in magnitude is equivalent to a factor of 2.5 in brightness, so Polaris the Pole Star is 7×10^8 times brighter than Halley's Comet at present). Confusion with an asteroid is regarded as extremely unlikely. The recovery was confirmed by M. Belton and H. Butcher who obtained accurate cometary coordinates on the nights of 18 and 20 October using a cryogenic camera and charge-coupled device on the 4 m Mayall telescope at the Kitt Peak National Observatory (*IAU Circ.* no. 3742). Their report of the unsuccessful search during winter 1981–82 can be found in *Nature* (**298,** 249; 1982).

No coma was detected, but this is hardly surprising because the surface temperature of the nucleus is expected to be about 120K. The recovery brightness indicates that the nucleus of the comet, assuming that it has a geometric albedo of 0.05, is about 9 ± 1 km across.

Halley's Comet, now termed 1982i, because it is the ninth new or recovered one this year, is in the constellation of Canis Minor. On 16.47569 October it was at a Right Ascension of 7 h 11 min 01.9 s and a declination of $+9°33'03''$, putting it only 0.6 s west of the position predicted by D. Yeomans (*The Comet Halley Handbook,* JPL 400-91 1/81; 1981). The comet is early and will pass perihelion some 8.6 h before the expected time of 9.66128 February 1986. At recovery Halley's Comet was 11.04 AU away from the Sun, so it has broken two records — it is the most distant comet ever seen, beating Stearn's Comet (1927 IV) by about 1 AU, and the faintest comet ever recorded.

The fact that Halley has been recovered 3.3 yr before perihelion passage is also amazing. At its 1910 return it was first seen on 11 September 1909 about 7.5 months before perihelion by Max Wolf, who used a one-hour photographic exposure with the 72 cm Heidenberg reflecting telescope. It was then at the outer edge of the asteroid belt about 3.4 AU from the Sun and of magnitude 16. It was 10 arc min from the predicted position and the previously predicted perihelion passage time was 3.03 days too early.

The Europeans were also first at the return before that. Dumouchel, the director of the Collegio Romano Observatory, obtained the first telescopic view of the comet on the morning of 6 August 1835, 3.3 months before perihelion passage. At that time the comet was 17 arc min in declination and 7 arc min in Right Ascension away from the predicted position, giving a predicted perihelion passage time 5 days too early.

So it seems that congratulations are in order. Yeomans' positional predictions have been proved to be extremely accurate, even though the comet is three times fainter than estimated. And the team who recovered the comet have pushed astronomical techniques to the limit and succeeded. All the scientists preparing space experiments for the 1986 perihelion passage of Halley's Comet can breathe a sigh of relief too. It is where it was expected to be, coming towards us at a speed of about 11 km s^{-1}; they have just got 8.6 h less time to get ready. □

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Confident carbon calibrations

from D.D. Harkness

SEVERAL proposals of fundamental importance to the confident interpretation of ^{14}C data were put forward at the 11th International Radiocarbon Conference*. Of major consequence was a plan to revise the constants and format used in the calculation and reporting of conventional ^{14}C years BP. In the event, the plan was overwhelmingly rejected in favour of the *status quo* — definition of the time scale by use of a half life of $5{,}570\pm30$ yr and the setting of AD 1950 as the zero age. Similarly, it was accepted that the expression of analytical uncertainty should remain as the individual laboratory's best estimate of one sigma statistical confidence in age measurement. In contrast, no agreement could be reached on the question of a standard procedure for isotopic normalization in the calculation of marine shell ages.

Routine accuracy in ^{14}C measurement was recently assessed in various laboratories on the basis of tree-ring dating (International Study Group *Nature* **298,** 619; 1982) and a review of the results suggested the need for a more frequent exchange of samples between laboratories and the uninhibited publication of such results. Practicing laboratories also welcomed the opportunity for collective assessment of the new reference material (1980 oxalic acid) issued by the US National Bureau of Standards. Following appraisal and discussion of its isotopic ratios, as measured relative to the established (1957 NBS oxalic acid) standard, the issue of the replacement standard was endorsed but it was noted that an accompanying statement on the isotopic enrichment factors proposed for routine dating work was desirable.

Causal mechanisms for variations in natural ^{14}C concentration received considerable attention and a consensus emerged that the established long-term and high-frequency (wiggle) variations in ^{14}C production rate primarily reflect changes in geomagnetic field intensity. Solar and climatic effects cannot be entirely precluded from the available tree-ring/^{14}C record but they are certainly small — no clear correlation is evident, for example, between the existing carbon isotope (tree-ring) record and historically recorded climate (M. Stuiver, University of Washington). Nevertheless, a measurable impact on the atmospheric ^{14}C inventory could be expected from the marked changes in the dynamics of the global CO_2 system during the glacial to postglacial transition (H. Oeschger, University of Berne). Beyond the range of dendrochronological comparison, parallel ^{14}C and ^{230}Th ages from cave deposits, which are concordant during the Holocene, indicate a higher ^{14}C content in the Peniglacial atmosphere — a major ^{14}C

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