COMET WEST (1975n)

Quite frequently, one sees a bright comet with a glowing tail in the early morning or evening sky and one such was the comet West (1975n), which is shown on the front cover. This comet was discoverd by Richard M. West of European Southern Observatory, Geneva on a photographic plate taken with the 100-Cm. Schmidt telescope at La Silla on 24th September 1975. The photograph showed that the tail was about 10″ long and the head 2″ to 3″ in diameter. Initial orbit of the comet indicated that it should be observable in the favourable position for observation in the northern sky in the mid March 1976. With improved values of the position of the comet, the perihelion passage was found to be around February 22, with $r = 0.232$ a.u and brightness $\backsim 0^m.5$ (*I.A.U.* circular No. 2871). Also the expected brightness of the comet for the period March 3 to 18 was to lie between $1^m.6$ to $4^m.6$ However, it turned out that comet was actually brighter by about 1 to 2 magnitudes than the predicted values for the same distance and the head and the tail could easily be seen with the naked eye in the early part of March. The photograph shown on the cover page was taken on the 13th March, 1976, with one hour exposure. The photograph clearly shows a straight narrow plasma tail and a well developed dust tail. The plasma tail also shows wave pattern which is generally attributed to arise from some form of instability in tail. As the comet was relatively bright, quite a few observations of various kinds have been carried out successfully (see *I.A.U.* Circular Nos. 2910, 2924, 2926, 2928).

The fluxes at various infrared band passes have been measured and the 10μ silicate feature is present in the comet. The albedo of the particles is found to be similar to that of comet Kohoutek. There was no evidence of antitail or the material on the sunward side. Spectroscopic observations show usual emissions of C_2, CN, C_3, Na and also H_2O^+.

H_α emission has also been detected. An Aerobee rocket launched on March 5, showed that the principal emissions to be OI λ1304, CI λ1561 and λ1657. The fourth positive bands of CO has also been detected. In the radio region, the emission at 1667 Hz due to OH has been observed. The peak intensity of this line on March 12, 13 and 14 was 0.15 Jy. The unusual characteristic of this comet was the presence of a secondary nucleus in the visual observations of March 5. Further observations confirmed the multiple nature of the nuclei and infact since March 11, observers have reported as many as four discrete condensations. The configuration of the condensations appears to be aranged in a trapezoidal form.

Detailed studies of several comets have helped in understanding various aspects of cometary physics. However, the origin of the comets is still far from clear. The best way to answer many of the questions is to send a space probe to the nucleus of the comet. These are completely feasible today from both technological and scientific point of view. In fact, NASA, U.S.A. has in mind such a mission for 1980's. Space missions of comets, coupled with increased ground-based research can help us in better understanding the nature and origin of this spectacular celestial visitor.

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SOLAR PULSATIONS

Recently, two independent observational findings by Severny, Kotor and Tsap (*Nature*, **259**, 87, 1976) and Brooks, Isaak and van der Raay (*Nature*, **259**, 92, 1976) have once again refocused attention on the problem of solar oscillations and pulsations. These results are significant since they provide the first direct evidence for large-scale global pulsations of the solar sphere. Previously, solar observers have been chiefly concerned with studying the properties associated with the well known 5-minute period photospheric fluctuations, and endeavoring to discover the excitation source, and the manner in which these oscillations propagate at photospheric and chromospheric levels. Severny et al. and, Brooks et al. have developed more sophisticated techniques and refined instrumental sensitivity to a level where photospheric fluctuations of 1 m sec^{-1} in amplitude are detectable. These observations independently claim to have established the existence of global oscillations of the entire Sun, with a mean period of approximately $2^h\ 40^m$, that correspond to an average radial velocity ranging from 2m sec^{-1} to 4.5 m sec^{-1}, and amplitude displacement of 10 km.

The methods employed by these groups involved different instrumental techniques. Severny et al. used a magnetograph at the magnetically insensitive photospherically formed line $\lambda = 5123.7$ A, from which a known shift in the line profile can be related to a Doppler line-of-sight velocity. The principle of the Doppler measurements involves a compensating device consisting of a plane-parallel glass plate that compensates a shift in profile against an absolute wavelength scale. By equalizing the signal output from two photomultiplier detectors centered oppositely in the wings of the spectral line, a Doppler shift of the line profile corresponds to an intensity difference that is proportional to the radial component of velocity.

Brooks et al. developed a sensitive instrument that employs either a K or Na vapour tube for calibration. The right - and left-hand circularly polarized light, after alternately exiting from an electro-optical light modulator, enters a K or Na tube, in which an artifically induced magnetic field of suitable strength splits the energy levels of K or Na atoms so that the anomalous Zeeman components coincide with the steepest portion of the wings of the solar spectral line. Thus, a small shift in the wings is detectable as an intensity difference, which in turn is proportional to the velocity.

The most outstanding result of these experiments is the remarkable agreement in the measured period. Severny et al. finds a mean period of $2^h\ 40^m \pm 0.5$ that was obtained in August-September, 1974 by averaging data obtained over a nine day period. The data points from each daily run were overlapped so as to increase the signal-to-noise, and the periodicity is apparent in the published observations. This procedure was repeated again in October, 1974 and March, 1975 and showed the same periodicity when the data was averaged in this manner. This raises an important question concerning the data analysis, since averaging the data sets in this fashion eliminates information concerning the phase stability of the wave trains. Severny et al. argues that a high degree of stability as extrapolated from the data sets in August-September, 1974 and March, 1975 demonstrates the relatively high degree of phase constancy. However, this result could be accidental, and further observations are required to verify this important property of the oscillations.

Similarly, Brooks et al. detected a dominant wave period around $2^h\ 39^m \pm 2.4$ in addition to peaks in the Fourier power spectrum at 58^m and 40^m. The power contained at $2^h\ 39^m$ is approximately one order of magnitude larger than the power in the higher order harmonic frequencies, and appears to be the dominant oscillation mode. The average amplitude was 2.7 ± 0.24 m sec^{-1} for one data set, and 4.5 ± 0.7m sec^{-1} in another series of observations, that corresponds to an oscillation period of $2^h\ 42^m \pm 6.0$.

The implications of these results have far reaching effects on stellar structure theory. Severny et al. suggest that the oscillations are purely radial pulsations of the Sun, for which the measured period of $2^h\ 40^m$ is very close to the value given by Ritter's simple formula $\sigma^{-2} = (3\Gamma - 4)$ g/R (Rosseland: 1964, *Pulsation Theory of Variable Stars*, Dover: New York, p.5) for a spherically homogeneous Sun. When $\Gamma = 5/3$ this yields a period of $2^h\ 47^m$. Accordingly, Severny et al. suggest that the well known (p,p) reactions in the core of the Sun in fact do not occur, and nuclear burning in the core does not account for the Sun's luminosity. They point out that this feature of their interpretation is consistent with the low neutrino flux measured by Davis (Bachall and Davis, Jr., *Science*, **191**, 264, 1976). However, an alternative suggestion for the solar energy source is not advanced by this group.

On the other hand, Dalsgaard and Gough (*Nature*, **259**, 87, 1976), suggests that these oscillations are best explained by assuming that they correspond to non-radial quadrupole pulsations of the solar sphere. Such pulsations would be consistent with a nuclear burning (p,p) core, and would incorporate current stellar structure models. However, these observations are not refined sufficiently to enable one to distinguish between the various modes of motion that can be present. More puzzling, however, is the question concerning the energy distribution in the oscillation spectrum. In particular, why the $2^h\ 40^m$ mode dominates other eigen mode solutions in the energy spectrum is a question that remains open to further interpretation and analysis.

The sensitivity claimed in both these experiments far exceeds the values quoted by other observers who use similar instrumentation. Most magnetographs operated in the Doppler mode usually claim as a lower threshold of sensitivity approximately 100m sec^{-1}. This is sufficient to detect the photospheric 5-minute period oscillations that have velocity amplitudes typically in the range 500m sec^{-1}. As an example, the Mount Wilson full disc magnetograph, that is similar conceptually to the magnetograph used by Severny et al., cannot detect motions of several meters per second. Guiding problems involving better than one arc second stability when positioning the entrance slit along the Sun's polar rotation axis can be an important factor when attempting to detect fluctuations that are comparable to the noise level in most magnetograph-Doppler machines. A clarification of these points is essential before these results can be completely accepted.

However, the close agreement between these two independent experiments does add considerable merit to the published results. If verified, this discovery can have important implications as far as our fundamental understanding of stellar interiors is concerned, and alter our basic concepts of the structure of stars.

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